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विभिन्न उत्सर्जन वर्गों के लिए रेडियो रिसीवरों की मापन पद्धतियाँ

भाग 3 आवृत्ति माडयूलित ध्वनि प्रसारण उत्सर्जन के लिए रिसीवरों के रेडियो-आवृत्ति मापन

Indian Standard

METHODS OF MEASUREMENT ON RADIO RECEIVERS FOR VARIOUS CLASSES OF EMISSIONS

PART 3 RADIO FREQUENCY MEASUREMENTS ON RECEIVERS FOR FREQUENCY MODULATED SOUND BROADCASTING EMISSIONS

UDC 621·396·62·083·621·317·3·029·4

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

March 1994 Price *Rs*. 220·00

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Indian Standard

METHODS OF MEASUREMENT ON RADIO RECEIVERS FOR VARIOUS CLASSES OF EMISSIONS

PART 3 RADIO FREQUENCY MEASUREMENTS ON RECEIVERS FOR FREQUENCY MODULATED SOUND BROADCASTING EMISSIONS

NATIONAL FOREWORD

This Indian Standard which is identical with IEC Pub 315-4 (1982) 'Methods of measurement on radio receivers for various classes of emissions — Part 4 : Radio-frequency measurements on receivers for frequency modulated sound-broadcasting emissions', issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on the recommendation of the Radio Communications Sectional Committee (LTD 20) and approval of the Electronics and Telecommunication Division Council.

In the adopted standard certain terminology and conventions are however not identical to those used in Indian Standards. Attention is particularly drawn to the following:

Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

CROSS REFERENCES

In this Indian Standard, the following International Standards are referred to. Read in their respective place the following:

International Standard	*Corresponding Indian Standard*
IEC Pub 106 Recommended methods of measurement of radiated and conducted interference from receivers for amplitude modulation frequency-modulation and television broadcast transmissions	IS 4546 : 1983 Methods of measurement of radiated and conducted interference from receivers for amplitude modulation, frequency modulation and television broadcast transmission (*first revision*) (Technically equivalent)
IEC 315-1 Methods of measurement on radio receivers for various classes of emission, Part 1 General conditions for measurements and measuring methods applying to several types of receivers IEC Pub 315-2 Part 2 Measurements particularly related to the audiofrequency part of a receiver	IS 12193 (Part 1) : 1989 Methods of measurement for radio receivers for various classes of emission: Part 1 General considerations and methods of measurements including audio frequency measurement (Technically equivalent)
IEC Pub 98 A First supplement to Pub 98 (1964) : Methods of measuring the characteristics of disk record playing units	IS 9729 : 1981 Methods of measuremeut of disk record playing equipment (Technically equivalent)
IEC Pub 225 Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations	IS 6964 : 1973 Octave, half-octave band filters for analysis of sound and vibrations (Technically equivalent)
IEC Pub 268-3 Sound system equipment, Part 3 Sound system amplifiers	IS 9302 (Part 2) : 1979 Characteristics and methods of measurement for sound system equipment: Part 2 Amplifiers (superseding IS 1032 : 1958) (Technically equivalent)

The technical committee responsible for the preparation of this standard has reviewed the provisions of the following International Publications and has decided that they are acceptable for use in conjunction with this standard:

IEC Pub 315-5 Methods of measurement on radio receivers for various classes of emission — Part 5 : Specialized radio-frequency measurements. Measurement on frequency-modulated receivers of the response to impulsive interference

CISPR Pub No. 13 Limits and methods of measurement of radio interference characteristics of sound and television receivers

IEV 151-04-03 International Electrotechnical Vocabulary (IEV) [IEC Publication 50 (151)] Chapter 151 : Electrical and magnetic devices

The text of Amendment No. 1 (1989) to IEC Pub 315-4 (1982) is being given at the end of this standard.

Only the English language text in the IEC Publication has been retained while adopting it in this standard.

CHAPTER I: GENERAL

SECTION ONE – INTRODUCTION

1. Object

This standard is intended to specify the conditions and methods of measurement to be used to determine the characteristics of a radio receiver, so as to make possible the comparison of results of measurements made by different observers. Limiting values of the various quantities for acceptable performance are not specified.

It constitutes a catalogue of selected measurements, recommended for assessing the essential properties of radio receivers. The methods of measurement are generally conceived to permit analyzing the overall performance of the receiver, considered as a quadripole (two-port) without any attempt to study its elements separately. However, depending on the characteristic to be measured and the type of receiver, it may be practicable, for experimental simplification, to carry out measurements on parts of the receiver by injection or extraction of signals at appropriate places in its circuits.

This standard is neither mandatory nor limiting, a choice of measurements being made in many cases. If necessary, additional measurements may be carried out, in accordance with standards laid down by other IEC Technical Committees or Sub-Committees or by other international standardization bodies.

2. Scope

This part describes methods of measurements to be applied to radio receivers (with or without audio amplifiers) designed for monophonic and stereophonic frequency modulated sound broadcast transmissions in ITU band 8 (VHF). Most of the methods are applicable to receivers designed for such broadcast transmission in other bands. It is intended to be used with IEC Publications 315-1: Methods of Measurement on Radio Receivers for Various Classes of Emission, Part 1: General Conditions for Measurements and Measuring Methods Applying to Several Types of Receivers, and 315-2: Part 2: Measurements Particularly Related to the Audio-frequency Part of a Receiver, in which general conditions and methods of measurement are given for various characteristics which are deemed to be applicable to all types of receivers.

Notes 1. – Methods of measurement of the immunity to impulsive interference entering through the antenna circuit are contained in IEC Publication 315-5, Part 5: Specialized Radio-frequency Measurements – Measurement on Frequency-modulated Receivers of the Response to Impulsive Interference.

2. — For the measurement of radiation from receivers, reference is made to IEC Publication 106: Recommended Methods of Measurement of Radiated and Conducted Interference from Receivers for Amplitude-modulation, Frequency-modulation and Television Broadcast Transmissions.

3. — F.M. broadcasting system characteristics are described in C.C.I.R. Recommendation 412-4. Stereophonic systems are described in C.C.I.R. Recommendation 450.

4. — See Table IV of IEC Publication 315-1. ITU Band 8 is defined in ITU Publication *Radio Regulations* (Geneva)

SECTION TWO — GENERAL NOTES ON MEASUREMENTS

3. Introduction

As the results of various measurements described in this part may be influenced by other properties of the receiver, the related measurements given in IEC Publications 315-1 and 315-2 should normally be carried out first.

4. Measurement accuracy

For information on the accuracy of measuring instruments, the presentation of results and deviations from the recommended methods, references shall be made to Section Two of IEC Publication 315-1. Measurement accuracy may be affected by interference from transmissions. Most of the measurements in this part should therefore be carried out in a suitable screened room.

For information on environmental conditions, reference shall be made to Section Three of IEC Publication 315-1.

5. Rated values

In this part the term "rated" is used in the special sense of the value specified by the manufacturer. This term is used in describing "rated conditions" and "rated values of characteristics"

5.1 *Rated conditions*

In order to define the electrical conditions under which the receiver performance is specified and shall be tested, the manufacturer shall state the following values:

- rated power supply voltage(s) and frequency (or frequency range);
- rated characteristic impedance of the r.f. signal source (where applicable);
- rated value of the substitute load (for each pair of output terminals) (See Sub-clause 6.2);
- rated total harmonic distortion at which the rated (distortion limited) output voltage or power is specified;
- rated environmental conditions (ranges of temperature, pressure and humidity).

These values, by their nature, cannot be determined by measurements.

5.2 *Rated values of characteristics*

The general and environmental conditions given in Clause 4 and the electrical conditions given in Sub-clause 5.1 enable the manufacturer to specify, and a testing authority to verify, the performance characteristics of the receiver. The manufacturer shall specify *rated values* for important characteristics.

Examples of such characteristics are:

- adjacent and alternate channel selectivity (Clause 49);
- usable sensitivity for a specified signal-to-noise ratio (Clause 64);
- ultimate signal-to-noise ratio (Clauses 65 and 77);
- distortion limited output voltage or power (Clause 9);
- maximum usable source available power or e.m.f., (Clause 12),

clearly defining whether these values are limit values or median values. In the latter case a tolerance shall be given.

6. Measurements at audio-frequency output terminals

6.1 *Measurement techniques*

The characteristics of devices such as loudspeakers and audio-frequency distribution lines for the connection of which output terminals are provided on receivers, are defined (for example in IEC Publication 268: Sound System Equipment) in terms of constant input voltage rather than constant input power. This applies not only to audio-frequency outputs but also to other outputs for example intermediate-frequency outputs and multiplex signal outputs. For this reason, it is at present accepted practice to make most measurements at output terminals in terms of the voltage across a substitute load. From this voltage, the power in the load may be calculated, if required, according to the formula:

$$P_2 = \frac{U_2^2}{R_2}$$

where the suffix 2 refers to output terminals as opposed to input terminals. Where the output signal is a substantially pure sinewave (e.g. less than 10% noise and distortion content), measurements may be made with an average-reading meter scaled in r.m.s. values for sinusoidal input. Under any other conditions, a true — r.m.s. meter shall be used, unless otherwise stated.

Where several pairs of output terminals are provided, the manufacturer shall state for each pair:

a) the rated value of the substitute load (referred to as "rated load impedance" in IEC Publication 268);

b) whether the pair of terminals shall be or shall not be connected to a substitute load when measurements are made at another pair of terminals.

Note. — It is usual to connect all terminals intended for loudspeakers to substitute loads for all measurements while pairs of terminals for other devices are loaded only when measurements are made at those terminals.

6.2 *Filters*

When making measurements at audio-frequency output terminals, unless it is specifically intended to measure low audio-frequency and ultrasonic components in the output voltage, it is

desirable to interpose a bandpass filter between the output terminals and the measuring instrument. In order to allow the use of practicable impedances in this filter the substitute load shall be connected directly to the audio-frequency output terminals. If the filter has significant insertion loss this shall be allowed for in determining the results.

It is advisable to use the same filter, for both monophonic and stereophonic receivers: this filter will prevent errors due to the presence of pilot-tone or sub-carrier components in the receiver output. The pass-band of this filter shall be 200 Hz to 15 kHz, for which frequencies the attenuation relative to that at 1 kHz shall not exceed 3 dB.

Below 200 Hz the attenuation slope shall tend to at least 18 dB per octave. At 19 kHz, the attenuation shall be at least 50 dB, and above 19 kHz it shall be at least 30 dB (see Figure 1a, page 101).

Usually this filter will prevent the results of measurements being affected by hum.

Filters for octave and third-octave band measurements shall comply with the requirements of IEC Publication 225: Octave, Half-octave and Third-octave Band Filters Intended for the Analysis of Sounds and Vibrations.

SECTION THREE — EXPLANATION OF GENERAL TERMS

7. Introduction

For the purpose of this standard, the following definitions shall apply:

7.1 *Carrier frequency*

The carrier frequency may be regarded either as the mean value of the instantaneous frequency or as the frequency generated in the absence of modulation, since with a perfect modulation system in which no d.c. component is involved and in which there is no non-linear distortion the two values are the same. Care should be taken to ensure that any possible shift of the mean carrier frequency due to modulation in the signal generator is sufficiently small to avoid affecting the measurements.

7.2 *Instantaneous frequency deviation*

Instantaneous frequency deviation is the difference between the instantaneous frequency of the modulated radio-frequency signal and the carrier frequency.

7.3 *Peak-to-peak frequency deviation*

Peak frequency deviation is the peak value of the instantaneous frequency deviation. Peak-to-peak deviation is defined as twice the peak frequency deviation.

In order to avoid confusion between 'peak frequency deviation' and 'peak-to-peak frequency deviation', peak-to-peak deviation shall be expressed as, for example, ±50 kHz.

Note. — "Peak-to-peak frequency deviation" is generally abbreviated to "deviation" in this standard.

7.4 *Rated maximum system deviation*

The rated maximum system deviation is the maximum peak-to-peak frequency deviation (see Sub-clause 7.3) specified for the system under consideration. In the case of frequency-modulation

systems in the ranges 65.8 MHz to 73 MHz and 87.5 MHz to 108 MHz, the rated maximum system deviation is ±50 kHz or ±75 kHz (see Note 3 of Clause 2.)

7.5 *Modulation and utilization factors*

By direct analogy with the case of amplitude modulation, the modulation factor of a frequency modulated signal is defined as:

$$\frac{\text{peak deviation of the signal} \times 100}{\text{rated maximum system deviation}} \%$$

Where part of the system deviation is taken up by one or more sub-carriers (for example in the pilot-tone system of stereophonic broadcasting), allowance is required in the design of the receiver for the consequent reduction in the maximum audio-frequency output available from the detector stage. It is convenient to define the utilization factor of such a signal as:

$$\frac{\text{peak deviation of the composite signal} - \text{peak deviation due to the sub-carrier(s)}}{\text{rated maximum system deviation} - \text{peak deviation due to the sub-carrier(s)}} \times 100\%$$

In order to avoid ascribing to a given deviation, different values of utilization factor depending only on the presence or absence of the sub-carrier(s) it is desirable to restrict the use of the term "utilization factor" to the case where the maximum sub-carrier deviation permitted by the system in use is allowed for and to define and express the measuring signals in terms of deviation rather than in terms of either modulation or utilization factor, thus avoiding any ambiguity or confusion.

7.6 *Standard value of deviation for measurements*

The standard deviation shall be 30% of the rated maximum system deviation, i.e. ±15 kHz or ±22.5 kHz. The *deviation* shall be stated with the results. Measurements at 100% modulation or 100% utilization are also important: where these are carried out the *deviation* used shall be stated with the results.

7.7 *Standard modulation frequency for measurements*

The standard modulation frequency shall be the standard reference frequency (1 000 Hz). When required, other frequencies shall be chosen, if possible, from the one-third octave band centre frequencies given in Table II of IEC Publication 315-1 (see also IEC Publication 225).

7.8 *Standard carrier frequencies for measurements*

The standard carrier frequency depends on the frequency allocations for f.m. broadcasting in the region where the receiver is to be used. Receivers within the scope of this standard usually cover the bands given in Table I. For these bands, the standard measuring frequencies are shown in the table.

TABLE I

Band coverage (MHz)	Standard measuring frequency (MHz)
65.8 to 73.0	69
76.0 to 90.0	83
87.5 to 104.0	94
87.5 to 108.0	98

7.9 *Standard radio-frequency input signal for measurements*

The standard radio-frequency input signal is a signal at the appropriate standard carrier frequency, modulated with the standard modulation frequency at the standard value of deviation (see Sub-clauses 7.6, 7.7 and 7.8). The available power from the source, at the receiver antenna terminals shall be 70 dB(fW), which may also be expressed as 40 dB(pW) (see Clause 53 of IEC Publication 315-1).

7.10 *Special radio-frequency input arrangements*

7.10.1 *Balanced inputs*

Certain f.m. broadcast receivers are equipped with a balanced antenna input circuit, usually with a rated characteristic impedance of 240 Ω or 300 Ω. Such receivers shall be measured with an impedance matched balanced signal source.

Where a balanced source is not available, the appropriate matching circuits of Clause 45 of IEC Publication 315-1 shall be used, or a "balun" transformer may be used, its insertion loss being allowed for. Care shall be taken that impedance matching is preserved throughout the circuit between the signal source and the antenna terminals of the receiver.

7.10.2 *Inputs for unipole antennas*

For portable f.m. receivers and f.m. car radios an unbalanced antenna input or a rod or telescopic antenna with a length of about one-quarter wavelength is usually provided.

Values of components to form a substitute circuit for these antennas depend on the signal frequency, the dimensions of the metal parts of the receiver and the antenna length. Values in common use are given in Table II. For circuit references see Figure 22, page 117

TABLE II

Frequency range (MHz)	Longest dimension of receiver cabinet (cm)	R_2 (Ω)	R_3 (Ω)	L (μH)	C_1 (pF)	C_2 (pF)	Circuit Figure
65.8 to 73	22 to 27	59	16	0.34	5.8	–	22a
65.8 to 73	27 to 33	50	25	0.5	6.0	–	22a
65.8 to 73	Above 33	28	47	0.78	5.4	–	22a
87.5 to 108	22 to 33	25	51	0.25	8.2	–	22a
65.8 to 108	Car radios	75	22	0.7	9.2	18	22b

These values are based on $R_1 = 75\ \Omega$. For other values of R_1, the value of the parallel combination of resistors R_3 and $R_1 + R_2$ in the circuit of Figure 22a, page 117, should remain the same as calculated from the table, the condition $R_2 + R_3 = R_1$ being also satisfied. In the circuit of Figure 22b, page 117, the value of R_2 should equal that of R_1. The values given are for an antenna length of 1.2 m and a housing capacitance of 18 pF. The length and capacitance of the antenna cable between the network and the receiver shall be stated with the results.

In determining the available power from the source the capacitor and inductor are deemed to be part of the receiver, so that the available power is measured or calculated at the point A in Figure 22, page 117.

The circuit and component values of the artificial antenna used, if other than those given above, shall be stated with the results.

The connection point for the low-potential terminal of the artificial antenna to the receiver shall be carefully chosen as it may greatly affect the results. The location of the connection point shall be stated with the results. During measurement of these types of receiver, care should be taken to avoid, if possible, connecting the receiver to the local earth, either via measuring equipment or via the mains.

7.11 *Tuning*

7.11.1 *Effect of automatic frequency control*

All tuning operations shall be made with arrangements for automatic frequency control inoperative, if this is possible, except when the performance of the automatic frequency control is being investigated.

When provision is made for the user to render the automatic frequency control inoperative, measurements may be made both with the automatic frequency control in operation, and with it disabled. The results shall clearly show whether the automatic frequency control was in operation or not.

7.11.2 *Preferred tuning method*

A list of tuning methods is given in Clause 55 of IEC Publication 315-1, of which, only method of Item *a)*, when applicable, precisely corresponds to the way an f.m. receiver is tuned in use. A method, which is applicable in the absence of a tuning indicator, corresponds more closely to the user's method, and is therefore preferred, is as follows:

The receiver shall be first tuned approximately to the signal and the audio-output signal observed on an oscilloscope. The deviation shall then be increased until the audio signal becomes distorted, and the receiver then tuned for symmetrical clipping of the audio signal, the volume control (if any) being adjusted so that overload of the audio-frequency part of the receiver does not occur.

If an alternative method of tuning is used, this shall be stated with the results.

7.12 *Standard measuring conditions*

A receiver is operating under standard measuring conditions when:

a) the power supply voltage and frequency are equal to the rated values;

b) the standard radio-frequency input signal is applied via the appropriate artificial antenna to the antenna terminals of the receiver;

c) the audio-frequency output terminals for connection to loudspeakers (if any) are connected to audio-frequency substitute loads;

d) the receiver is tuned to the applied signal in accordance with Sub-clause 7.11.2;

e) the volume control (if any), is adjusted so that the output voltage at the main audio-frequency output terminals is 10 dB below the rated distortion-limited output voltage (measurements may also be made according to Clause 36 of IEC Publication 315-1, the power or equivalent voltage then being clearly stated with the results);

f) the environmental conditions are within the rated ranges;

g) for stereo receivers, the balance control or its equivalent, (if any) is adjusted so that the output voltages of the two channels are equal;

h) the tone controls if any, are adjusted for the flattest possible audio-frequency response (e.g. for equal response at 100 Hz, 1 kHz and 10 kHz);

i) the automatic frequency control is inoperative, if this can be achieved by means of a user control (see note);

Note. — Where a user control for automatic frequency control is provided, measurements should in general be made both with automatic frequency control off (which will allow easy analysis of the results), and with automatic frequency control on (which represents the situation when the receiver is in normal use). The two sets of results should be clearly identified.

If the automatic frequency control cannot be made inoperative by means of a user control, it may nevertheless be necessary (or desirable) for the automatic frequency control to be disabled for certain measurements. In this case the automatic frequency control should be disabled by temporarily modifying the receiver, the action taken being detailed with the results (see Sub-clause 7.11.1).

k) the muting control, if any, is in the "muting off" position.

CHAPTER II: FIDELITY

8. General

The fidelity of reproduction of a receiver depends on the characteristics of the radio-frequency and intermediate-frequency parts, in addition to those acoustic and audio-frequency characteristics which are dealt with in IEC Publication 315-2.

The fidelity of stereophonic reproduction depends also on the similarity of the overall amplitude and phase response versus frequency characteristics of the output channels (see Clause 31), on the crosstalk between channels (see Clause 40) and on cross-intermodulation effects (see Clause 27).

Distortion may arise in the receiver where the signal exists in its frequency-modulated form, and in its multiplex form in the case of stereophonic reception. In the latter case both non-linear distortion of the channel signals and non-linear crosstalk will probably result. Some of the significant intermodulation products produced will probably be in the ultrasonic frequency range.

Distortion arising after decoding does not necessarily cause non-linear crosstalk. This distortion is considered in Chapter II of IEC Publication 315-2.

To ensure that distortion measurements are not invalidated by noise, at each stage the output obtained with an unmodulated carrier shall be noted and shown in the results. Measurements of distortion components will be valid only if appreciably higher (e.g. 10 dB) than the measured noise (see Note 1 of Clause 10).

SECTION FOUR – OVERALL TOTAL HARMONIC DISTORTION AS A FUNCTION OF OUTPUT VOLTAGE AND MODULATION FREQUENCY

9. Introduction

The overall total harmonic distortion is the total harmonic distortion of the audio-frequency output signal, measured with a specified radio-frequency input signal and a specified modulation frequency. It is a function of the audio-frequency output voltage or power.

From the results, the distortion limited output voltage or power and other output characteristics, may be determined.

10. Method of measurement

The receiver is brought under standard measuring conditions (see Sub-clause 7.12), and the total harmonic distortion of the audio-frequency output voltage at the terminals under consideration is measured. The measurement may be repeated for other modulation frequencies within the audio-frequency range, but not exceeding 5 kHz in the case of stereophonic receivers. If a volume control is provided, measurements may be made at other settings of this control, and also at other settings of the tone controls. Measurements may also be made with various values of deviation up to and including the rated maximum system deviation (see Clause 15).

For a stereophonic receiver, each channel shall be measured separately, with the other channel unmodulated. Measurements may be made with both channels modulated at the same frequency, and with various phase relationships. These results will give information on the influence of the power supply on distortion.

An example of a circuit arrangement for these tests is shown in Figure 1, page 100. For monophonic measurements the circuit can be simplified.

The measurements are carried out with S_1 in position 3 (and then 4), and S_2 in position 1 (and then 2).

Notes 1. — For these measurements and those described in Clauses 13, 16, 19 and 25, a total harmonic distortion meter, which measures all audio-frequency components except those close to or equal to the fundamental frequency is recommended. Individual components may be measured, if required, by means of a wave analyzer.

2. — Where channel balance controls are provided, or an equivalent arrangement, they should be adjusted so that each channel gives approximately the same output voltage.

11. Presentation of the results

The distortion characteristics may be expressed graphically with total harmonic distortion plotted as ordinate, linearly either as a percentage or in decibels, preferably referred to the level of the fundamental. The abscissa may be: output voltage or power plotted logarithmically, or linearly in decibels referred to a stated reference (see Figure 2, page 102); or modulation frequency plotted logarithmically.

The output voltage or power for a stated value of total harmonic distortion may also be plotted as ordinate; linearly in decibels with modulation frequency as abscissa (an example is given in Figure 3, page 102).

SECTION FIVE — OVERALL DISTORTION AS A FUNCTION OF INPUT POWER

12. Introduction

Significant distortion of the modulation may occur in the radio-frequency, intermediate frequency and detector stages of the receiver both at very low and at very high values of radio-frequency input power. Where an audio-frequency volume control (or controls) is provided, it should be adjusted, for these measurements, so that the distortion introduced by the audio-frequency stages is as low as possible, but for some receivers particularly with high output audio amplifiers, the audio-frequency noise and distortion may not under any conditions be negligible compared with the distortion due to the other stages of the receiver. In such a case, measurements should be made at the low-level audio output terminals, if any.

13. Method of measurement

The receiver is brought under standard measuring conditions. The input signal is then reduced to equal the noise-limited sensitivity (Clause 68) and the deviation increased to the rated maximum system deviation. Where provided, the volume control is adjusted so that the noise plus distortion due to the audio-frequency part of the receiver is minimized (see Clauses 19 and 20 of IEC

Publication 315-2). The input signal level is then increased in steps of, for example, 10 dB, adjusting, where provided, the volume control to keep the audio-frequency output voltage approximately constant. The receiver tuning is checked at each stage.

The value of total harmonic distortion in the audio-frequency output signal of the channel being measured, is noted for each value of input power.

For stereophonic receivers, each channel may be measured separately.

The measurements may be repeated for other modulation frequencies, and other values of deviation. Measurements may also be made at the input to the audio-frequency amplifier, particularly if terminals are provided at this point.

14. Presentation of the results

Curves showing the total harmonic distortion as a function of the radio-frequency input power are plotted on linear scales: with the total harmonic distortion either as a percentage or in decibels, preferably referred to rated distortion, limited output voltage or power, as ordinate and the input signal level in dB(fW) as abscissa (see Figure 4, page 103).

SECTION SIX – OVERALL DISTORTION AS A FUNCTION OF THE DEVIATION

15. Introduction

The shape of the amplitude and phase versus frequency responses of the radio-frequency and intermediate frequency parts of the receiver, and of the detector, may introduce distortion which is a function of the deviation. Undesired audio-frequency feedback via the automatic frequency control circuits may also produce this effect.

16. Method of measurement

The method is described in Clause 10. Where provided, the volume control should be adjusted as described in Clause 13 so that the noise plus distortion of the audio-frequency stages is minimized.

For stereophonic receivers measurements may be made with the channels modulated equally in-phase and equally in anti-phase.

Note. – Measurements at values of deviation greater than the rated maximum system deviation may be of value in some cases.

17. Presentation of the results

Curves showing the total harmonic distortion as a function of the deviation are plotted: with the total harmonic distortion, either as a percentage or in decibels, preferably referred to rated distortion-limited output voltage or power, linearly as ordinate and the deviation in kilohertz linearly as abscissa (see Figure 5, page 103).

SECTION SEVEN – DISTORTION ARISING FROM INACCURACY OF TUNING

18. Introduction

When measuring distortion according to Clauses 10, 13 and 16, the receiver is tuned by the preferred method which may not correspond to minimum distortion at all values of deviation and input power. To assess this effect, the distortion may be measured at several values of carrier frequency within the passband of the receiver.

For receivers with pre-set or automatic-search tuning systems (see Clauses 77 to 82 of IEC Publication 315-1), the permissible departure of the actual tuning position from the correct position is determined by the extra harmonic distortion introduced thereby.

19. Method of measurement

The receiver is brought under standard measuring conditions and the deviation increased to equal the rated maximum system deviation. Where provided, the volume control shall be adjusted as described in Clause 13 to minimize the noise plus distortion of the audio-frequency stages. The total harmonic distortion of the audio-frequency output signal is noted. The input signal frequency is then varied within the passband of the receiver, and the total harmonic distortion measured at each frequency, adjusting the volume control, where provided, to keep the audio-frequency output voltage approximately constant.

Measurements may be repeated at other values of input power. The results obtained will be considerably affected by automatic-frequency control if provided. If the automatic-frequency control can be switched off, measurements should be made with and without automatic-frequency control.

For pre-set tuned receivers, measurements should be made with each pre-set adjusted so that collectively they cover the whole tuning range of the receiver.

Note. – These measurements may conveniently be combined with those described in Clause 56.

20. Presentation of the results

Curves showing the distortion arising from inaccuracy of tuning are plotted: with the distortion either as a percentage, or in decibels referred to the level of the fundamental frequency, linearly as ordinate and the difference between the nominal tuning frequency and the input carrier frequency linearly as abscissa (see Figure 6, page 104).

If a special tuning method is used (see Sub-clause 7.11.2), this should be stated with the results.

SECTION EIGHT – DISTORTION IN THE R.F., I.F. AND DECODER CIRCUITS AS A FUNCTION OF THE FREQUENCY OF THE MODULATING SIGNAL

21. Introduction

The finite bandwidth of the receiver, and the characteristics of the stereo decoder, if provided, may cause significant non-linear distortion which is a function of the frequency of the modulating signal.

22. Method of measurement

The measurement is performed as described in Clause 10 but with the volume control, if provided, adjusted to minimize the noise plus distortion of the audio-frequency stages as described in Clause 13.

Measurement should be made at 15 kHz or 22.5 kHz deviation, 100% utilization and rated maximum system deviation, and may also be made at other values of deviation.

For stereophonic receivers measurements should be made:

a) with both channels modulated in phase (S_1 in Figure 1, page 100, in position 1);

b) with both channels modulated in anti-phase (S_1 in Figure 1 in position 2);

c) with each channel in turn, only, modulated (S_1 in Figure 1 in position 3 or 4).

The results represent mainly harmonic distortion for modulation frequencies up to about 5 kHz. For monophonic receivers the results for modulation frequencies above 7.5 kHz represent noise, while for stereophonic receivers, the results for these modulation frequencies will be mostly difference-frequency distortion products (see Clause 30).

23. Presentation of the results

The results are presented graphically as described in Clause 11. An example is shown in Figure 7, page 104.

SECTION NINE – DISTORTION AS A FUNCTION OF POWER SUPPLY VOLTAGE AND DISTORTION AS A FUNCTION OF AMBIENT TEMPERATURE

24. Introduction

Generally, measurements of these and similar characteristics are mostly used in the process of receiver design, rather than for verification of specifications. Therefore, it is usual to choose a method of measurement which is particularly suitable for investigating the precise design feature being investigated. The methods given are therefore no more than a guide.

25. Methods of measurement

25.1 *Influence of the power supply voltage*

The measurement is made according to Clause 10, with the power supply voltage set at various values within the range, if any, given by the manufacturer, or in accordance with Table I of IEC Publication 315-1. The output voltage or power at which measurements are made shall be stated with the results.

25.2 *Influence of ambient temperature*

The measurement is made according to Clause 10, with the ambient temperature set at various values within the range, if any, given by the manufacturer, or in accordance with Clause 11 of IEC Publication 315-1.

Care should be taken to distinguish between effects due to ambient temperature and effects due to self-heating in the receiver which are largely independent of ambient temperature.

26. Presentation of the results

The results may be expressed graphically with power supply voltage or ambient temperature as abscissa, or as families of curves with these variables as parameters.

SECTION TEN — INTERMODULATION DISTORTION

27. Introduction

Intermodulation distortion in the detected or decoded audio-frequency signal may be caused by non-linearity in the radio-frequency, intermediate-frequency and detector stages of the receiver, particularly by the effects of a limited intermediate frequency bandwidth and detector non-linearity. Where an audio-frequency amplifier is provided, its intermodulation distortion may not be negligible, so that measurements are often best made at the input to this amplifier, particularly if terminals are provided at this point. For stereophonic receivers, difference — frequency distortion products from the modulating frequency and the pilot tone or sub-carrier or their harmonics may fall within the audio-frequency band, for example, for the pilot tone system, this will occur for second — order intermodulation between a modulating signal at 4 kHz, or above, with the 19 kHz pilot tone frequency.

28. Method of measurement

28.1 *Intermodulation within the channel*

The receiver is brought under standard measuring conditions and the volume control (if any) then adjusted according to Clause 12. The modulation is then changed to two equal amplitude signals at 1 kHz and approximately 1.2 kHz at ±33.75 kHz deviation so that the maximum (peak) deviation is ±67.5 kHz, and the output voltage or power measured at each modulation frequency at approximately 200 Hz and multiples thereof, and at any other frequency below 15 kHz at which significant output is obtained. Measurements are repeated with other pairs of modulation frequencies separated by approximately 200 Hz, up to 14.8 kHz and 15 kHz. A difference-frequency of approximately 200 Hz, is chosen for convenience of measurement with a selective voltmeter, the exact frequency being chosen to avoid interference from power-supply harmonics.

Measurements may be repeated at other values of deviation. For stereo receivers, measurements shall be made first with equal modulations applied to both channels in-phase, second with equal modulations in anti-phase, with pilot-tone or subcarrier present in each case, and third with equal, in-phase modulations without pilot-tone or subcarrier. These measurements will show the effects of decoder operation on intermodulation distortion. Measurements shall not extend beyond 100% utilization.

Note. — The deviations given above refer to a rated maximum system deviation of ±75 kHz: where the rated value is ±50 kHz the deviations are ±22.5 kHz and ±45 kHz, respectively.

28.2 *Cross-intermodulation between the channels of a stereo receiver*

Modulation is applied at a frequency of 8.7 kHz to one channel and at a frequency of 11 kHz to the other channel, at equal deviation such that the maximum peak utilization is 100%. (For example, for the pilot tone system, each deviation will be 33.75 kHz peak so that when the peak deviations occur at the same instant the total deviation will be 67.5 kHz which is 100% utilization for the pilot-tone system).

Note. — These frequencies are known to be suitable for the pilot tone system (and acceptable for other systems). They are chosen in preference to two of the standard frequencies given in IEC Publication 315-1 so that intermodulation products arising from different mechanisms have easily distinguishable frequencies.

The output voltage or power at each modulation frequency and of each significant intermodulation product present in the output of each channel within the audio-frequency range shall be measured with a selective voltmeter, including products due to ultrasonic components of the composite signal.

Measurements may be repeated with the channel modulations reversed, also at a maximum peak deviation of 30% of rated maximum system deviation. In order to measure the intermodulation distortion at lower modulation frequencies, measurements may be made with other pairs of frequencies such as 900 Hz and 1 100 Hz. Full details of the frequencies, deviations, etc., shall then be given with the results.

29. Presentation of the results

The results shall be expressed as spectra in the form of a table. The reference value shall be the output (of one channel in the case of stereo) produced by the standard radio-frequency input signal. Products due to ultrasonic components of the composite signal shall be identified. An example of the results of measurements according to Sub-clause 28.2 is given in Figure 8, page 105.

30. Additional measurement for intermodulation due to ultrasonic components

The receiver is brought under standard measuring conditions and the volume control (if any) then adjusted according to Clause 13. The modulation is then changed to be equal and in-phase in both channels, at 100% utilization, and the output voltage or power of each channel at 1 kHz measured selectively. The measurement is repeated with modulation frequencies of 13 kHz, 10 kHz and 6.67 kHz in turn for the pilot tone system, and 15 kHz and 10 kHz for the polar-modulation system, all these frequencies being chosen so that their harmonics lie 1 kHz for the former system and 1.25 kHz for the latter system from ultrasonic components of the composite signal; the output is measured selectively at 1 kHz or 1.25 kHz respectively. The results may be shown in a table, the outputs due to intermodulation being expressed in decibels relative to the output produced by 1 kHz modulation, equal and in-phase in both channels at 100% utilization.

SECTION ELEVEN — OVERALL STEREOPHONIC IDENTICALITY FACTOR

31. Introduction

The overall stereophonic identicality factor is the ratio expressed in decibels of the algebraic sum of the outputs of the two audio channels, when the modulating signals applied to the stereo encoder are equal and in-phase, to the algebraic sum of the outputs when the modulating signals are equal and in phase opposition.

32. Method of measurement

32.1 *Overall stereophonic identicality factor*

The receiver is brought under standard measuring conditions in a circuit arrangement as shown in Figure 1, page 100, with S_1 in position 2, S_2 in position 1 or 2. Then S_2 is put into position 3. Where a balance control or equivalent arrangement is provided, it is now adjusted for minimum indication on the meter whose reading is noted with S_1 in position 1 and with S_1 in position 2. The overall stereophonic identicality factor is then

$$20 \log \left\{ \frac{\text{output with } S_1 \text{ in position 1}}{\text{output with } S_1 \text{ in position 2}} \right\} \text{ at 1 kHz}$$

The measurement is repeated for frequencies from 200 Hz up to at least 3 kHz, keeping a constant deviation of 15 kHz or of 22.5 kHz.

Normally, it is not necessary to use a selective voltmeter but in case of doubt as to whether hum, noise or distortion are affecting the results, selective measurement should be used.

The measurements may be repeated at other values of deviation and of input signal level.

32.2 *Overall interchannel phase difference*

The phase angle between the two output signals may be measured by connecting the two inputs of a phase meter to the points A and B in Figure 1. The switch S_1 shall be in position 1.

If a phase meter is not available, the phase difference between the channels can be calculated from

$$\varphi = \text{arc cos}\ \frac{V_1^2 + V_2^2 - 4V_3^2}{2V_1\ V_2}$$

where V_1, V_2 and V_3 are the voltages measured on the meter of Figure 1 with S_1 in position 2 and S_2 in positions 1, 2 and 3, respectively. The band-pass filter shall be removed from the circuit for this measurement, but since φ will normally be small, it is advisable to use a selective voltmeter to minimize errors.

Measurements should be made over the frequency range 40 Hz to 15 kHz.

33. Presentation of the results

Curves showing the oveall stereophonic identicality factor as a function of modulation frequency are plotted with modulation frequency as abscissa on a logarithmic scale and the stereophonic identicality factor as ordinate in decibels on a linear scale. The overall interchannel phase difference may be shown on the same graph, with degrees plotted linearly as ordinate.

SECTION TWELVE — OVERALL AUDIO-FREQUENCY RESPONSE

34. Introduction

The overall audio-frequency response may be influenced by the properties of the intermediate frequency stages, the detector, decoder and de-emphasis circuits.

35. Method of measurement

The receiver is brought under standard measuring conditions but without using the filter mentioned in Sub-clause 6.2 and then the output voltage or power is measured with several modulation frequencies, either by keeping a constant deviation of ± 22.5 kHz (or ± 15 kHz) and allowing for the effects of de-emphasis by correcting the results according to the relevant standard pre-emphasis (50 µs or 75 µs), or by setting the deviation at ± 15 kHz (± 10 kHz) with a modulation frequency of 100 Hz and including an accurate pre-emphasis network in the modulation chain.

For stereophonic receivers, each channel shall be measured in turn, also with equal modulation in each channel, and in both mono and stereo modes.

If a "loudness control" (physiologically-compensated volume control) is fitted, and the compensation cannot be switched off, measurements shall be carried out with the loudness control set at minimum attenuation, and the deviation reduced to avoid overload of the audio-frequency part of the receiver. This shall be stated with the results.

36. Presentation of the results

Curves showing the output voltage or power as a function of modulation frequency are plotted with modulation frequency as abscissa on a logarithmic scale and output as ordinate in decibels on a linear scale.

The reference level shall be clearly stated. Curves for the two channels of a stereo receiver may be plotted on the same graph, the channels being clearly identified (see also Figure 13 of IEC Publication 315-2).

SECTION THIRTEEN — OVERALL INTERCHANNEL GAIN DIFFERENCE INCLUDING ITS VARIATION WITH THE VOLUME CONTROL SETTING

37. Introduction

The audio-frequency volume control characteristic may be measured for each channel of a stereophonic receiver according to Clause 43 of IEC Publication 315-2. An overall measurement may be more convenient, especially if the receiver has no a.f. input terminals, or if the results using these terminals might be different from those of the overall measurement.

38. **Method of measurement**

The receiver is brought under standard measuring conditions and the output voltage or power from each channel measured for various known settings of the volume control without further adjustment of the balance control or equivalent arrangement. The output level from the left-hand channel shall be conventionally taken as reference and the output level from the right-hand channel, expressed in decibels, referred to it. Measurements should extend to a volume control attenuation of 46 dB and may be made at other modulation frequencies if required.

39. **Presentation of the results**

The results shall be expressed graphically, with the volume control setting in degrees, millimetres or percentage of total travel as abscissa on a linear scale and interchannel gain difference in decibels linearly as ordinate. Alternatively, the left channel volume control attenuation may be plotted in decibels as abscissa, with the inter-channel gain difference in decibels linearly as ordinate.

Note. — Where two separate volume controls are fitted, it is assumed that at each setting the user adjusts for balance aurally.

SECTION FOURTEEN — CROSSTALK ATTENUATION

40. **Introduction**

Crosstalk exists if signals originating in one channel only of a stereophonic system give rise to audio-frequency components in the output of the other channel of the receiver. The crosstalk attenuation is the ratio expressed in decibels of the output of a channel due to a signal intended for that channel to the output of the other channel due to the same signal.

Note. — The output voltage of a channel X due to an input intended for channel Y may be denoted by $(U_X)_Y$.

The *crosstalk attenuation* from channel A to channel B is then defined as:

$$20 \log \frac{(U_A)_A}{(U_B)_A}$$

The *separation* of channel A from channel B is defined as:

$$20 \log \frac{(U_A)_A}{(U_A)_B}$$

(see Clause 26 of IEC Publication 268-3: Sound System Equipment, Part 3: Sound System Amplifiers, and Sub-clause 5.7 of IEC Publication 98A: First supplement to Publication 98: Processed Disk Records and Reproducing Equipment — Methods of Measuring the Characteristics of Disk Record Playing Units). These quantities are normally of the same order but not equal. With some types of stereo receiver they may differ considerably, because $(U_B)_A$ and $(U_A)_B$ are different.

41. Method of measurement

The receiver is brought under standard measuring conditions in a circuit according to Figure 1, page 100. The switch S_1 is then set to position 3, giving modulation in the A channel only at ± 15 kHz or ± 22.5 kHz deviation, and the outputs from the two channels are noted. The measurement is repeated at other modulation frequencies. S_1 is then set to position 4, giving modulation in the B channel only, and the outputs from the two channels again noted. The measurement is repeated at other modulation frequencies.

Selective measurements may be made in order to eliminate the effects of noise or to separate linear crosstalk from non-linear crosstalk. *The total crosstalk measured selectively* is the r.m.s. sum of the individual crosstalk components.

The measurements may be repeated for other values of deviation, pilot-tone level and input signal power.

42. Presentation of the results

Curves of crosstalk attenuation are plotted with modulation frequency as abscissa on a logarithmic scale and crosstalk attenuation in decibels as ordinate on a linear scale (see Figure 17 of IEC Publication 315-2).

Note. — The first set of results from the method of Clause 41 gives $(U_A)_A$ and $(U_B)_A$, i.e. the crosstalk from channel A into channel B. Results of measurements at other pilot-tone levels shall include details of pilot-tone level used.

CHAPTER III: SELECTIVITY

SECTION FIFTEEN — INTRODUCTION

43. Explanation of terms

The *selectivity* of a receiver is a measure of its ability to discriminate between a wanted signal to which the receiver is tuned and unwanted signals entering through the normal antenna circuit.

The *susceptibility* of a receiver is a measure of its sensitivity to signals, including the wanted signal, entering otherwise than through the normal antenna circuit (e.g. through the power supply or through an antenna system intended for another frequency range).

A *single-signal method* of measurement measures the response of the receiver to an unwanted signal in the absence of the wanted signal. The results of such a measurement are meaningful only if the receiver is operating in a linear mode both during the measurement and in the condition to which the measurement results are to be applied.

A *two-signal method* of measurement measures the response of the receiver to an unwanted signal in the presence of the wanted signal. The receiver operating mode may be non-linear provided that the results are applied only to conditions where only one strong unwanted signal is present.

A *three-signal method* of measurement is of value, where the wanted signal is accompanied by strong unwanted signals at equal frequency separations above and below the wanted frequency (such conditions occur in practice in some countries).

The *audio-frequency signal-to-interference ratio** is the ratio expressed in decibels of the wanted signal to the unwanted signal, measured at the audio-frequency output terminals of the receiver under specified conditions. When this ratio is given a particular numerical value for some purpose, the numerical value is known as the audio-frequency protection ratio.

A value of 30 dB is specified in this chapter; other stated values, for example 50 dB, may be used if required.

The *radio-frequency wanted to interfering signal ratio** is the ratio expressed in decibels of the wanted radio-frequency signal to the interfering radio-frequency signal at the input terminals of the receiver.

The value of this ratio, which produces at the output terminals an audio-frequency signal-to-interference ratio equal to a specified audio-frequency protection ratio, is known as the radio-frequency protection ratio.

44. Standard conditions for measurement

Unless otherwise stated, selectivity measurements shall be made for an audio-frequency protection ratio of 30 dB. When modulated the deviation of both wanted and unwanted signals shall be ±15 kHz or ±22.5 kHz unless otherwise stated.

* These terms correspond to "a.f. protection ratio" and "r.f. protection ratio" respectively, in the terminology of the C.C.I.R. (Recommendation 447-1).

45. Theoretical correlation between methods

Provided that the receiver is linear under all conditions of measurement, the two-signal method will give an interfering signal level about 10 dB higher than the single-signal method. In practice, little correlation is obtained, due to non-linear effects.

SECTION SIXTEEN – CAPTURE RATIO

46. Introduction

The capture ratio of a receiver describes its ability to receive a stronger signal in the presence of a weaker interfering signal having the same carrier frequency. If the ratio of the signal strength exceeds the capture ratio the measured audio-frequency signal-to-interference ratio will be large (of the order of 30 dB) but if both signals are modulated audible interference may still occur ("co-channel hiss"). The capture ratio is defined as half the difference between the signal level of an interfering carrier at the wanted frequency which reduces the receiver audio-frequency output level due to a wanted signal deviated ±15 kHz or ±22.5 kHz at a modulation frequency of 1 kHz by 1 dB, and the signal level of the interfering carrier which reduces the receiver audio-frequency output by 30 dB.

47. Method of measurement

The wanted and unwanted signals are simultaneously applied by means of a combining network in accordance with Clause 47 of IEC Publication 315-1. As a preliminary, the tuning and output levels of the two signal generators shall be cross-calibrated, as the required accuracy for this measurement normally exceeds that of direct calibrations. One signal is set to zero output and the other adjusted to standard r.f. input signal (Sub-clause 7.9). The receiver is carefully tuned in accordance with Sub-clause 7.11.2 and the audio output voltage or power noted (the volume control, if any, may be adjusted to give a convenient value of output). The modulation is then removed and the other, unmodulated, generator adjusted to an output level of 60 dB(pW) and tuned for a low-frequency beat note (e.g. 200 Hz) at the receiver audio output. The second generator output level is then adjusted, preferably by means of a continuously variable attenuator, until the amplitude of the beat note is at a maximum. Alternatively, a counter may be used to set the two generators accurately to the same frequency, after the output levels have been cross-calibrated as above.

The output frequencies and levels of the two generators will then be equal for the purposes of the following measurement.

The modulation is reapplied and the output signal level of the unmodulated generator is adjusted until the audio output signal level is 1 dB below the previously noted value. The output signal level of the unmodulated generator is noted.

Note. – In this condition the modulated signal has "captured" the receiver.

The output signal level of the unmodulated generator is now increased until the audio output signal level is 30 dB below the previously noted value, and the output signal level of the unmodulated generator again noted.

Note. – In this condition, the unmodulated signal has "captured" the receiver.

The capture ratio is calculated as half the difference between the two previously noted values of generator output signal level. Since the capture ratio depends on the receiver amplitude modulation suppression and bandwidth, which in turn are functions of signal level, it may be desirable to repeat the measurement at other input signal levels.

48. Presentation of the results

Curves are plotted with the input signal level (in decibels) of the modulated carrier as abscissa on a linear scale and the capture ratio in decibels as ordinate on a linear scale. An example is given in Figure 10, page 106.

SECTION SEVENTEEN – REJECTION OF SIGNALS FROM ALTERNATE, ADJACENT AND CO-CHANNELS

49. Introduction

Receivers are required to reject signals whose carrier frequencies are near to the wanted carrier frequency. For a high value of audio-frequency signal-to-interference ratio (e.g. 30 dB), however, the input signal level required at frequencies within about 400 kHz of the wanted signal may be less than that of the wanted signal. In stereophonic receivers, particularly when operating in the stereo mode, the rejection of close interfering carriers is less than that of a mono receiver, due to the greater bandwidth of the stereo receiver and possible effects in the decoder (see Clause 96).

The measurement may be made with the interfering carrier sinusoidally modulated (Clause 50) or modulated with weighted pre-emphasised noise (Clause 51). The latter method gives results which correlate well with subjective test results but the apparatus required is more complex. The noise weighting is chosen so that the spectrum of the noise resembles that of modern (Western European) dance music, which is a particularly critical form of modulation in the case of adjacent channel interference.

50. Method of measurement using sinusoidal modulation

The wanted and unwanted signals are applied simultaneously by means of a combining network in accordance with Clause 47 of IEC Publication 315-1. The unwanted signal is first set to zero output and then the standard radio-frequency input signal (Sub-clause 7.9) is applied as the wanted signal. The receiver is then carefully tuned in accordance with Sub-clause 7.11.2.

The measurements will be seriously affected by the action of automatic frequency control which should therefore be switched off or disabled. The action taken shall be stated with the results. Measurements can also be made with the automatic frequency control in operation (see Clause 55).

The audio-frequency output voltage or power shall be noted (see Sub-clause 6.1). (The volume and balance controls, if any, may be adjusted for convenient equal outputs from both channels of stereophonic receivers.) The modulation of the wanted signal is then removed but if the receiver is

being measured in the stereo mode the pilot tone or subcarrier modulation shall be present. The unwanted signal is then adjusted to the required frequency and modulated monophonically ±15 kHz or ±22.5 kHz deviation, in the case of co-channel measurement, and at ±26.7 kHz or ±40 kHz deviation, in the case of adjacent channel or alternate channel measurement, with a modulation frequency of 1 kHz. The frequency difference between the wanted and unwanted signals shall be accurately measured with a frequency counter or similar technique. The direct calibrations of the signal generators may not be of the accuracy required for this measurement (better than 0.1%). The level of the unwanted signal is then adjusted to give an audio-frequency signal-to-interference ratio of 30 dB or other stated value. The modulation of the unwanted carrier should then be removed and the audio-frequency output should fall by at least 10 dB. This ensures that the measurement is not affected by hum, or noise, including that from the signal generators or broadcast transmitter interference. It is often helpful to listen to the receiver output.

Measurements should be made for unwanted carrier frequencies spaced on each side of the wanted carrier by 0 kHz, 25 kHz, 50 kHz, 75 kHz, 100 kHz, 150 kHz, 200 kHz, 250 kHz, 300 kHz, 400 kHz, 500 kHz, 600 kHz, 700 kHz, 800 kHz, 900 kHz, and 1 000 kHz, or 0, 1, 2, and 3 channel spacings for particular broadcasting standards. The wanted signal frequency may be chosen so as to avoid interference from broadcast transmitters. Additional measurements may be made at other wanted signal levels and for other values of audio-frequency signal-to-interference ratio.

The results obtained will vary significantly with the deviation. Measurements should therefore be made at other values of deviation, taking into consideration national broadcasting standards and practices.

51. Method of measurement using noise modulation

The method of Clause 50 shall be used with the following changes:

51.1 The unwanted signal, instead of being modulated with 1 kHz, shall be modulated by a noise signal which is obtained from a Gaussian white noise generator, passing the signal through a weighting filter as specified in Figure 11, page 106, followed by a low-pass filter having a cut-off frequency of 15 kHz and a slope of 60 dB/octave, and then through a pre-emphasis network (50 µs or 75 µs).

The audio-frequency amplitude versus frequency characteristic of the modulation stage of the signal generator should not vary by more than 2 dB up to the cut-off frequency of the low-pass filter.

The accuracy of the measurement depends very much on the precision with which frequency deviation of the signal generator can be set; this is especially true for the unwanted transmitter. The line-up procedure therefore should be carried out very carefully.

The deviation of the signal shall be adjusted by means of the arrangement shown in Figure 12, page 107. The meter V shall be a quasi-peak voltmeter (see Appendix A). To obtain the required deviation conditions, the switches S_1, S_2 and S_3 are placed in position 1 and the modulation at 500 Hz from the audio-frequency generator adjusted to ±32 kHz (±21.3 kHz) deviation. The meter reading is noted. The switch S_1 is then placed in position 2 and the noise modulation adjusted to give the same reading on the quasi-peak meter.

Note. — The deviation with 500 Hz modulation should be checked with a deviation meter unless the deviation meter (if any) included in the signal generator is known to be accurate.

51.2 For the determination of the reference level, the wanted signal is frequency modulated, using a sinusoidal tone of 500 Hz with the rated maximum system deviation.

The switches are set as follows: S_1 in position 1, S_2 in position 2 and S_3 in position 3. The reading of the meter V indicates the reference level.

51.3 The noise voltmeter used to measure the wanted and interfering signals at the output of the receiver consists of a quasi-peak voltmeter with defined dynamic characteristics and an added filter which modifies the levels of the interfering frequencies according to their subjective interference effect as specified in Appendix A (see note).

51.4 The audio-frequency signal-to-interference ratio should be measured at the low-level audio-frequency output of the receiver. If this is not possible, the tone-controls shall be in a position to ensure a flat audio-frequency response (see Item *h)* of Sub-clause 7.12).

The level of the unwanted signal is adjusted to obtain an audio-frequency signal-to-interference ratio of 50 dB at the audio-frequency output of the receiver, the value of 50 dB being chosen in this case to correspond with C.C.I.R. Recommendation 412-4. In this case, the weighting network of the quasi-peak voltmeter shall be switched in (switch 3 in position 2). The ratio between the radio-frequency levels of the wanted and unwanted signals is the required radio-frequency wanted-to-interfering signal ratio.

Note. — These characteristics correspond with those given in C.C.I.R. Recommendation 468-2.

52. Presentation of the results

Curves are plotted with the audio-frequency signal-to-interference ratio and the wanted input signal level as parameters. The frequency difference between the wanted and unwanted signals is plotted linearly as abscissa and the radio-frequency wanted-to-interfering signal ratio expressed in decibels linearly as ordinate (see Figure 13, page 109).

SECTION EIGHTEEN — AMPLITUDE MODULATION SUPPRESSION

53. Introduction

The amplitude modulation suppression ratio of a receiver represents the ability of the receiver to reject amplitude modulation of the input signal. Such modulation may result from fading, multi-path signals, aircraft flutter, amplitude modulation at the transmitter and amplitude modulation introduced in the receiver by passband limitations and mistuning.

54. Method involving output voltage (or power) comparisons

54.1 *Simultaneous method*

The circuit arrangement for this measurement is given in Figure 14, page 110. The receiver is first brought under standard measuring conditions and the deviation then changed to rated maximum system deviation at 1 kHz modulation frequency, adjusting the volume control (if any) to prevent overload in the a.f. part of the receiver.

With switch S_1 in position 1 the output voltage U_1 due to the 1 kHz modulation is measured.

With the frequency modulation maintained, the carrier is then amplitude modulated 30% at 400 Hz. It is essential that no spurious frequency modulation is introduced thereby.

With S_1 in position 2 and S_2 in position 4 the output voltage U_2 is measured, filter F_6 (Figure 14, page 110 being adjusted for minimum U_2; this output is due to the 400 Hz modulation and the intermodulation components at 600 Hz and 1 400 Hz due to both modulation frequencies.

The amplitude modulation suppression ratio is then given by:

$$20 \log \frac{U_1}{U_2}$$

The measurement may be repeated at other values of amplitude modulation factor and other radio-frequency input signal levels.

54.2 *Sequential method*

In this method, the input signal is *either* amplitude *or* frequency modulated, which does not represent the conditions that occur in practice. In some cases, the errors of this method may be large, and whenever possible the results should be compared with those obtained by the "simultaneous" method.

The receiver is first brought under standard measuring conditions and the deviation then changed to rated maximum system deviation, adjusting the volume control (if any) to prevent overload in the audio-frequency part of the receiver. The output voltage U_1 is then measured.

The modulation is then changed to 30% amplitude modulation at 1 kHz and the output voltage U_2 measured.

The amplitude modulation suppression is the ratio $\frac{U_1}{U_2}$ expressed in decibels.

Note. — This method is suitable for comparing the performance of several samples of the same circuit design, but not for comparing different designs, for which the method of Sub-clause 54.1 should be used.

SECTION NINETEEN — TUNING CHARACTERISTICS

55. Introduction

The tuning characteristic of a receiver shows the relation between the audio-frequency output voltage and the operating frequency when the applied signal frequency is varied each side of the frequency to which the receiver is tuned.

The tuning characteristic is modified by the action of automatic frequency control. The characteristic measured with automatic frequency control in operation shows the pull-in and hold-in ranges.

56. Method of measurement

The receiver is brought under standard measuring conditions and then the input signal level reduced so that the receiver is operating below limiting level (see Section Twenty-six). Under these

conditions the signal-to-noise ratio may be very low: if so, the audio-frequency output at 1 kHz should be measured selectively (e.g. with a wave analyzer or third-octave filter), this being stated with the results. The input signal level used shall also be stated. The input signal frequency is now varied in steps either side of the original frequency and the output voltage (or power) is measured at each step.

The measurement may be repeated at other input signal levels. If automatic frequency control is fitted, the measurements shall be repeated with it in operation. The input signal frequency is first varied stepwise *away* from the original frequency until a sudden drop in audio frequency output occurs, and then varied stepwise *towards* and beyond the original frequency until the output suddenly drops again. The input signal is then varied back towards the original frequency again. From these measurements the "hold-in" and "pull-in" ranges of the automatic frequency control may be determined (see Figure 15, page 111). Alternatively, instead of maintaining the audio output level, the local oscillator frequency may be measured with a frequency counter at each value of input signal frequency.

The measurements may be repeated at other signal levels.

Notes 1. — Some types of automatic frequency control do not function satisfactorily if the pull-in range is wide, because the receiver is detuned from a weak signal in the presence of a strong signal on a nearby frequency. Other types of automatic frequency control can have a very wide hold-in range associated with a narrow pull-in range and these are affected less by strong signals. Due to the wide variety of effects that may occur, it is difficult to standardize a method of measurement; a method based on that of Clause 50 is often suitable but with the unwanted signal unmodulated and the wanted signal modulated. The change of audio-frequency output when the unwanted carrier is applied is a measure of its interference with the automatic frequency control action.

2. — These measurements may conveniently be combined with those given in Clause 19.

57. Presentation of the results

The output voltage (or power) is plotted in decibels on a linear scale, the reference voltage or power being stated. The difference between the input signal frequency and the original frequency (the detuning) is plotted linearly as abscissa; a logarithmic scale may be used if the detuning range is large. An example is given in Figure 15. If the local oscillator frequency is measured, its frequency shall be plotted in megahertz linearly as ordinate. An example is given in Figure 16, page 111.

SECTION TWENTY — REJECTION OF UNWANTED SIGNALS ENTERING THROUGH THE ANTENNA

58. Introduction and explanation of terms

In addition to the responses to signals at frequencies near to the tuning frequency, superheterodyne and similar receivers respond to unwanted signals at the intermediate frequency (or frequencies, in the case of double or multiple superhets), the image frequency (or frequencies) and at harmonics of the signal frequency and other frequencies associated with harmonics of the local-oscillator frequency (or frequencies).

These responses may be measured by single-signal or two-signal methods, and there are important differences both in the conditions of measurement and in the results obtained. It is essential therefore to distinguish clearly in the results which measurement has been made, particularly when

a stereophonic receiver is measured in the stereophonic mode. Non-linear effects in the input stages of the receiver may be produced by combinations of several input signals; three-signal methods of measurement can be used in this case.

The *single-signal intermediate-frequency rejection ratio* is the ratio in decibels of the input signal level at the intermediate frequency to the input signal level at the tuning frequency for *equal* values of audio-frequency output voltage or power. The input signal level at the tuning frequency shall be below limiting level (Section Twenty-six) and the audio-frequency output shall be measured selectively if the signal-to-noise ratio is low.

The *two-signal intermediate-frequency rejection ratio* is the ratio in decibels of the interference signal level, at the intermediate frequency, to the r.f. signal level, at the tuning frequency, which fulfils the following conditions:

1) The interference signal frequency and level are such that the unwanted a.f. signal, due to intermodulation, is at a frequency of 1 kHz and at a level 30 dB below that due to the standard r.f. input signal.
2) The wanted signal level is such that the audio-frequency signal-to-noise ratio, in the absence of the unwanted signal, is at least 30 dB.

If the receiver has a balanced input circuit, two values of each of the above characteristics may be measured, one with the intermediate-frequency signal applied in the unbalanced mode, and one with the intermediate-frequency signal applied in the balanced mode. The former is usually more important in practice when the receiver is connected directly to an aerial not shared with another receiver.

The *image frequency* of a superheterodyne or similar receiver is equal to the tuning frequency plus or minus twice the intermediate frequency according to whether the local heterodyne oscillator is higher or lower, respectively, in frequency than the signal frequency.

Double and multiple superhet receivers have several image frequencies for each tuning frequency.

Note. — The automatic frequency control (if any) will not function correctly with an input signal at image frequency.

The *single-signal image rejection ratio* is the ratio in decibels of the input signal level at the image frequency to the input signal level at the tuning frequency for *equal* audio-frequency output voltage or power. The input signal level at the tuning frequency shall be below limiting level (Section Twenty-six) and the audio-frequency output shall be measured selectively if the signal-to-noise ratio is low.

The *two-signal image rejection ratio* is the ratio in decibels of the input signal level at the image frequency to the input signal level at the tuning frequency producing a 30 dB signal-to-noise ratio that is, for a 1 kHz beat-note output *30 dB below* the audio-frequency output due to the signal at the tuning frequency.

Spurious response frequencies are those frequencies f_s related to the oscillator frequency f_o and the intermediate frequency f_i by the following equations:

i) $f_s = f_o \pm \frac{f_i}{n}$, where n is an integer greater than 1.

Notes 1. — The responses for values of n greater than 2 are often but not always insignificant.

ii) $f_s = f_o$.

2. — This response can only be measured by a two-signal method (see Clause 61).

iii) $f_s = nf_o \pm f_i$, where n is zero or an integer greater than 1.

59. Methods of measurement (single signal)

59.1 *Method using a modulated signal*

The receiver is brought under standard measuring conditions and the −3 dB limiting level measured (Section Twenty-six), together with the corresponding value of audio-frequency output voltage or power. The signal frequency is then changed approximately to the appropriate intermediate, image or spurious response frequency, the input signal level increased and the input frequency adjusted for maximum audio-frequency output. The input signal level is then adjusted for the same audio-frequency output voltage or power as produced in the measurement of −3 dB limiting level. When measuring the single signal intermediate-frequency rejection in the unbalanced mode, the input signal shall be applied through the artificial antenna for the appropriate frequency range (see Clause 44 of IEC Publication 315-1). If the receiver has a balanced input circuit, the intermediate-frequency signal shall be applied between the two input terminals connected together and the signal earth of the receiver, the method of connection being fully described in the results.

59.2 *Method using noise-suppression*

The method of Sub-clause 59.1 is used, but instead of adjusting the measuring signal to obtain equal audio-frequency outputs under reference and measuring conditions, the measuring signal is unmodulated and the receiver noise output measured, the input signal level being adjusted for equal noise outputs under reference and measuring conditions, the noise output level being reduced by the presence of the signal. This method can be used for stereophonic receivers in the stereo mode if pilot-tone modulation only is applied. Some of the spurious responses of a receiver are due to mechanisms that produce deviation multiplication. For these responses, the results of the modulated signal and noise-suppression methods will be significantly different.

59.3 *Rejection of an amplitude-modulated signal at the intermediate frequency*

Under consideration.

60. Presentation of the results

The single-signal intermediate frequency and image frequency rejection ratios for a given signal frequency may be tabulated, or plotted in decibels as ordinate on a linear scale as a function of the tuning frequency as abscissa on a linear scale. An example is shown in Figure 17a, page 112. The results of measurements of individual spurious responses may be reported in the same way. Spectra showing all significant spurious responses with a single tuning frequency should also be shown. An example is shown in Figure 17b, page 113. It shall be made clear that the results were obtained by a single-signal method and which method was used (Sub-clauses 59.1 or 59.2).

61. Method of measurement (two-signal)

The procedure of Clause 50 is followed, except that the wanted signal level shall be adjusted to produce a signal-to-noise ratio of 30 dB in the absence of the unwanted signal and the unwanted signal is adjusted approximately to the appropriate intermediate-frequency image or spurious response frequency, the wanted signal removed and the modulated unwanted signal frequency

adjusted for maximum audio-frequency output. The modulation is then removed, the wanted signal reapplied and the unwanted signal frequency adjusted to obtain a beat-note frequency of 1 kHz. The unwanted signal level shall then be adjusted to produce a beat-note output voltage or power 30 dB below the output voltage or power produced by the modulated wanted signal in the absence of the unwanted signal. The beat-note output shall be measured selectively.

This method is suitable for the measurement of response to a signal at oscillator frequency, which cannot be measured by a single-signal method.

Difficulties in using this method for high-performance receivers have been reported. It is essential that the signal generators are extremely stable in frequency.

62. Presentation of the results

The two-signal intermediate-frequency image and spurious frequency responses may be presented in the same way as the single-signal responses (Clause 60). It shall be made clear that the results were obtained by *two-signal methods.*

SECTION TWENTY-ONE — SPURIOUS RESPONSES CAUSED BY STRONG SIGNALS

63. Introduction

One or more strong signals entering the receiver may result in spurious responses by several mechanisms. One or more of the signals may be at a frequency outside the tuning range of the receiver. Some of these responses can be measured by two-signal methods, but one can be measured only by a three-signal method (Sub-clause 63.4). Particularly important responses occur when the interfering signal frequencies and the tuning frequency are equally spaced, and methods of measurement for these responses are given.

For other responses which may be important in particular cases, similar methods are usually suitable.

It is essential that the signal generator(s) used for these measurements have adequately low outputs at frequencies other than that intended. Preferably they should be checked for spectral purity with a spectrum analyzer, and suitable filters employed to remove any spurious output which could cause errors.

63.1 *Two-signal method using modulation*

This method measures the effects of intermodulation produced in the radio-frequency part of the receiver when two signals of frequencies f_1 and f_2 are sufficiently strong to generate an unwanted radio-frequency signal at the tuning frequency f_s (intermodulation of the type $2f_1 - f_2 = f_s$). The whole procedure of Clause 50 is followed except that after the first measurement of output voltage or power, the two-signal frequencies f_1, f_2 shall be adjusted so that they satisfy one of the following equations:

$$f_1 = f_s \pm \Delta f$$

$$f_2 = f_s \pm 2\Delta f$$

like signs being taken together, where f_s is the tuning frequency.

When either of these equations is satisfied, f_1, f_2 and f_s are equally spaced. To avoid effects due to selectivity, the spacing Δf should usually be not less than 300 kHz.

The signal which is further in frequency from the tuning frequency shall be modulated as given in Clause 50, with the other signal unmodulated. One frequency shall be carefully adjusted to obtain maximum audio-frequency output. The input signal levels at the two frequencies shall be equal and shall be adjusted to obtain an audio-frequency output voltage or power *equal* to that obtained in the first measurement. Frequency separations from ±400 kHz to at least ±2 200 kHz should be used for measurement.

63.2 *Two-signal method using noise-suppression*

This method measures the effects of the same type intermodulation in the radio-frequency part in Sub-clause 63.1.

The procedure of Sub-clause 63.1 is followed except that in the first part of the test, the wanted signal level shall be the noise-limited sensitivity for a signal-to-noise ratio of 20 dB (see Clause 68), and instead of adjusting the measuring signals to obtain equal audio-frequency outputs under reference and measuring conditions, the measuring signals are unmodulated and the receiver noise output measured, the input signal levels being adjusted for *equal* noise outputs under reference and measuring conditions, the noise output being reduced by the presence of the signal.

63.3 *Three-signal method*

This method measures the effects of intermodulation of the type $f_1 + f_2 = 2f_s$ in the radio-frequency part.

The procedure of Clause 61 is followed, except that three signals are applied by means of a suitable combining network, the frequencies being the standard measuring frequency and two frequencies equally spaced on either side of it, one of the unwanted frequencies being adjusted for maximum beat-note amplitude and the other then adjusted to bring the beat-note frequency to 1 kHz. The input signal levels at the two unwanted frequencies shall be equal and shall be adjusted to produce an output power 30 dB below the output voltage or power produced by the modulated wanted signal alone. The beat-note output level shall be measured selectively.

Frequency spacings from ±800 kHz to at least ±2 200 kHz shall be used for the measurements.

63.4 *Spurious responses due to a single amplitude-modulated signal at a frequency just outside the normal tuning range*

Other radio services using amplitude modulation may operate on adjacent channels just outside the normal tuning range of an f.m. receiver. The method of measurement described below is intended to measure not only the nearby selectivity, but also the spurious responses due to front-end overload, etc. The unwanted signal is amplitude-modulated.

63.4.1 *Method of measurement*

The method as described in Clause 50 shall be used with the following changes. The unwanted signal, instead of being frequency-modulated, shall be amplitude-modulated, using a modulation depth of 90%. The modulation frequency is 1 kHz. The wanted carrier-frequency shall be the lowest channel centre frequency of the broadcast service. Frequency spacings from 50 kHz to at least 2 200 kHz shall be used for the measurements.

63.5 *Presentation of the results*

The ratio in decibels of the unwanted signal level to the wanted signal level is plotted linearly as ordinate with the difference between the wanted and unwanted signal frequencies plotted linearly as abscissa. The method used (Sub-clause 63.2, 63.3 or 63.4) shall be clearly stated, together with the tuning frequency.

Note. — (To Section Twenty-one) As an alternative to observing the audio-frequency in the above measurements, the amplitude of the intermediate-frequency signal, *at a stage in the receiver before limiting occurs,* produced by the standard radio-frequency input signal may be compared with that produced by the signal defined in the relevant sub-clause above. This comparison may be carried out using a radio-frequency wave analyzer or a spectrum analyzer.

CHAPTER IV: SENSITIVITY

SECTION TWENTY-TWO — INTRODUCTION

64. General

The sensitivity of a receiver is a measure of its ability to receive weak signals and produce an audio-frequency output of usable magnitude and acceptable quality.

Sensitivities may be defined with respect to many different criteria of the output signal, including the following:

a) signal-to-noise ratio (Sections Twenty-three and Twenty-four);

b) output voltage or power (with the volume control, if any, at maximum) (Section Twenty-five);

c) limiting level (Section Twenty-six).

For sensitivity measurements a circuit such as that shown in Figure 14, page 110, is used.

The *usable sensitivity* of a receiver is the noise-limited or gain-limited sensitivity, whichever is the greater value of input signal level.

Note. — For some receivers, the distortion caused by insufficient bandwidth at very low input signal levels may present a practical limit to useful sensitivity.

SECTION TWENTY-THREE — SIGNAL-TO-NOISE RATIO

65. Introduction

The signal-to-noise ratio of a receiver, under specified conditions, is the ratio of the audio-frequency output voltage due to the signal to that due to random noise. The noise may be measured:

a) using the band-pass filter defined in Sub-clause 6.2 and Figure 1a, page 101, together with a true r.m.s. meter or an average-responding meter calibrated in r.m.s. values for a sinusoidal signal, or

b) using the weighting network and meter defined in Appendix A, or

c) using a band-pass filter with a 3 dB-bandwidth of 22.4 Hz to 15 kHz (see Figure 1c, page 101) together with either of the meters given in Item *a)* above.

Since these different methods give significantly different results, it is essential that the method used be clearly stated with the results.

66. Methods of measurement

66.1 *Sequential method*

Using the circuit of Figure 14, the receiver is brought under standard measuring conditions with S_1 and S_2 in position 1 and the attenuator A set to zero attenuation. The modulation of the signal is

then removed, S_1 set to position 2 and the reading of the voltmeter noted. S_1 is then returned to position 1 and modulation reapplied at rated maximum system deviation; the attenuator A being adjusted to obtain the same reading on the voltmeter as before. The signal-to-noise ratio is then equal to the attenuator setting. The measurement may be repeated at other signal frequencies and with other settings of the tone control(s), if any. For measurements on stereo receivers in the stereo mode, pilot-tone modulation, where applicable, is retained when the 1 kHz modulation is removed.

66.2 *Simultaneous method*

The presence of a modulated signal can under certain circumstances increase rather than reduce the noise output of a f.m. receiver.

The following method allows for this effect.

Using the method of Sub-clause 66.1, instead of removing the modulation, S_2 is moved to position 2 so that the output due to the fundamental of the modulation frequency is filtered out.

The setting of the attenuator A for equal readings on the voltmeter with S_1 in either position is then equal to the ratio in decibels of the (signal plus noise plus distortion) to the (noise plus distortion) (so-called SINAD measurement). The measurement should be repeated at other values of deviation.

For stereophonic reception, the two channels shall be modulated in phase opposition. Each output channel is measured in turn, using the circuit of Figure 14, page 110

66.3 *Unweighted (band-limited) measurements*

The measurements shall be made according to Sub-clause 66.1 or 66.2, except that the filter F_2 in Figure 14 shall be replaced by a filter with a 3 dB bandwidth of 22.4 Hz to 15 kHz, complying with the requirements shown in Figure 1c, page 101.

67. Presentation of the results

Curves are plotted showing the signal-to-noise ratio expressed in decibels linearly as ordinate as a function of input signal level expressed in decibels (referred to 1 fW, preferably) as abscissa on a linear scale.

The method employed (Sub-clause 66.1 or 66.2) should be clearly stated.

For the simultaneous method, families of curves with deviation as parameter may be plotted. An example is shown in Figure 18, page 114 (see also Clause 74).

SECTION TWENTY-FOUR — NOISE-LIMITED SENSITIVITY

68. Introduction

The noise-limited sensitivity of a receiver is the minimum value of radio-frequency input signal level producing a specified signal-to-noise ratio at the audio-frequency output.

The reference audio-frequency output signal level is that produced by rated maximum system deviation.

69. **Method of measurement**

The results can be deduced from the measurements according to Clause 66. It is advisable to measure the signal-to-noise ratio for sufficient values of input signal level to ensure that rapid changes in the signal-to-noise ratio are fully explored.

The measurement may be repeated at several input signal frequencies.

70. **Presentation of the results**

The noise-limited sensitivity is plotted linearly in decibels (preferably referred to 1 fW) as ordinate, as a function of input signal frequency plotted linearly in megahertz as abscissa.

An example is given in Figure 19, page 114. Families of curves may be plotted with signal-to-noise ratio as parameter. The measurement method used shall be clearly stated (Sub-clause 66.1 or 66.2).

SECTION TWENTY-FIVE — GAIN-LIMITED SENSITIVITY

71. **Introduction**

A receiver is said to be gain-limited if the audio-frequency output voltage or power, measured selectively at the modulation frequency with a small signal input is less than the rated distortion-limited output voltage or power.

Note. — The receiver may be capable of producing a *reference* output voltage or power (e.g. 100 mV or 50 mW) but this may be much less than the output claimed by the manufacturer and that required to operate correctly with associated equipment.

The *gain-limited sensitivity* is the least value of radio-frequency input signal level, modulated at 1 kHz with 22.5 kHz (15 kHz) deviation, which will produce an audio-frequency output voltage or power 10.5 dB below rated distortion-limited output voltage or power with the volume control, if any, at maximum.

Note. — A reduced deviation and output level are used to avoid overloading effects.

72. **Method of measurement**

The method of Sub-clause 66.2 is used, but keeping the switch S_2 in position 3 so that only the fundamental of the modulation frequency is measured, and keeping the attenuator A at zero attenuation. The input signal level is adjusted to give an output level 10.5 dB below the rated distortion-limited output.

The measurement may be repeated at other frequencies, and for the stereophonic mode.

73. Presentation of the results

The gain-limited sensitivity is plotted linearly in decibels (preferably referred to 1 fW) as ordinate, as a function of input signal frequency plotted linearly in megahertz as abscissa.

Pairs of curves may be plotted for monophonic and stereophonic operation.

An example is shown in Figure 20, page 115.

SECTION TWENTY-SIX – OUTPUT/INPUT CHARACTERISTIC

74. Introduction

One of the most important and informative characteristics of a receiver is the relationship between the audio-frequency output voltage or power and the radio frequency input available power, particularly if the noise output voltage (Clause 65) is plotted as a function of input signal level on the same graph as the audio-frequency output voltage or power.

Many characteristics of the receiver may be determined from such a graph, for example:

a) noise-limited and gain-limited sensitivities;
b) 3 dB limiting level;
c) overloading effects not shown by the measurements in Section Five;
d) amplification reserve,
e) deviation sensitivity;
f) ultimate signal-to-noise ratio.

For stereophonic reception, the following characteristics among others, may also be determined:

g) input signal level at which the stereo decoder begins to function;
h) signal-to-noise ratio in the stereo mode;
j) hysteresis in stereo decoder switch-on.

These terms are explained in Clause 77.

75. Method of measurement

Using the circuit arrangement of Figure 14, page 110, with S_1 in position 1, the receiver is first brought under standard measuring conditions (Sub-clause 7.13) and the deviation then increased to rated maximum system deviation. The radio-frequency input signal level is then reduced to a low value (e.g. -30 dB (fW)) and the audio-frequency output voltage or power measured. The radio-frequency input signal level is then increased in steps, measuring the output voltage or power at each step.

For measurements at low input signal levels where the signal-to-noise ratio is poor, S_1 may be put into position 2 and S_2 in position 3, so that the output voltage is measured selectively at 1 kHz. If this is done, it shall be reported in the results. After every increase in input signal level, the receiver shall be retuned (Sub-clause 7.11.2). Any significant change of tuning with input signal level shall be reported in the results.

If the receiver has an audio-frequency power amplifier, this may become overloaded as the input signal level is increased above 70 dB(fW).

This shall be avoided by increasing the volume control attenuation by a known amount whenever the output voltage or power would otherwise have been greater than one-third of the rated distortion-limited value.

The measurement may be repeated at other values of deviation, particularly 100% utilization in the stereophonic mode.

76. Presentation of the results

A curve is plotted with the radio frequency input available power level (preferably referred to 1fW) linearly as abscissa and the audio-frequency output voltage or power expressed in decibels, referred to a stated reference, linearly as ordinate. Corrections shall be made for any increases in the volume control attenuation to avoid overloading. Families of curves may be plotted for different values of deviation, and curves for monophonic and stereophonic reception may be plotted on the same graph, together with the respective signal-to-noise ratio characteristics.

An example is given in Figure 21, page 116.

77. Explanation of terms

The *−3 dB limiting level* is the input signal level at which the audio-frequency output voltage level is 3 dB below the value at a specified high input signal level, preferably 85 dB(fW).

The *amplification reserve* of a receiver fitted with a volume control is the attenuation in decibels of the volume control when adjusted to produce rated distortion-limited output voltage or power with a specified high radio-frequency input signal level, preferably 85 dB(fW), with a modulation frequency of 1 kHz, at rated maximum system deviation.

The *deviation sensitivity* of a receiver is the value of deviation required to produce rated distortion-limited output voltage or power with the volume control (if any) set at maximum, and at a specified high radio-frequency input signal level, preferably 85 dB(fW).

The *ultimate signal-to-noise ratio* of a receiver is the value of signal-to-noise ratio for input signal levels sufficiently high that no significant increase in signal-to-noise ratio occurs when the input signal level is increased.

The *stereo threshold* is the input level at which the stereo decoder begins to operate: a marked decrease in signal-to-noise ratio is usual at this signal level unless signal-strength dependent crosstalk circuits are included.

The *stereo indicator threshold* is the input signal level at which the visual indicator shows that the receiver is operating in the stereo mode: it may or may not be identical with the stereo threshold.

The *muting threshold* is the input signal level at which the muting circuits allow the audio-frequency signal to appear at the output terminals.

Note. — The thresholds are often different according to whether the signal strength is decreasing or increasing. This hysteresis is usually intentional as it prevents unsatisfactory operation with input signal levels at or near threshold value.

The *muting attenuation* is the reduction in audio-frequency output due to an input signal modulated at 1 kHz at rated maximum system deviation, selectively measured at 1 kHz, when the muting is switched on.

CHAPTER V: INTERFERENCE DUE TO INTERNAL SOURCES

SECTION TWENTY-SEVEN — SINGLE-SIGNAL WHISTLES

78. **Introauction**

Whistles (any type of audible beat-note) may be caused by the generation of harmonics of the intermediate-frequency near the wanted signal frequency, resulting in an audio-frequency beat-note. These harmonics may be generated in the intermediate-frequency amplifier or detector stages and may be radiated to earlier stages of the receiver, particularly in the case of harmonics falling within the tuning range of the receiver.

79. **Determining the effects of whistles**

79.1 *Method of measurement*

The receiver is brought under standard measuring conditions and the audio-frequency output voltage or power noted. The modulation is then removed and the input signal frequency varied over the desired frequency range which should extend from the intermediate frequency up to at least the highest tuning frequency. At each input frequency the receiver is tuned over its tuning range (with the automatic frequency control inoperative if a user control is fitted) and for any beat-note that is observed, the input signal frequency is adjusted so that the beat-note frequency is approximately 1 kHz. The audio-frequency output voltage or power due to the beat-note is then measured, selectively if the signal-to-noise ratio is low. Particular attention should be given to frequencies near harmonics of the intermediate-frequency which fall within the tuning range, the receiver being tuned near to the harmonic frequency.

79.2 *Presentation of the results*

The results are presented in the form of a table showing the input signal frequency, the receiver tuning frequency and the effective deviation of the whistle, calculated from the ratio of the audio-frequency output due to the whistle to that due to the standard radio-frequency input signal.

SECTION TWENTY-EIGHT — POWER-SUPPLY FREQUENCY INTERFERENCE

80. **Introduction**

The radio-frequency stages, particularly mixer stages, of a receiver may give rise to hum, due to amplitude or frequency modulation of the signal by low audio-frequency voltages from the supply mains or elsewhere, or electric or magnetic fields. Automatic frequency control circuits, in particular, can cause hum due to frequency-modulation of the local oscillator.

81. Method of measurement

The receiver is brought under standard measuring conditions but without using the filter described in Sub-clause 6.2 and then the modulation frequency is changed to 80 Hz so that comparison of the signal and hum is less influenced by the frequency response of the audio-frequency stages. The modulation is then removed and the hum output is measured as separate spectral components with a wave analyzer or as total hum output with a true r.m.s. meter.

The measurement should be repeated at other input signal levels, and with automatic frequency control in operation.

Note. — Care should be taken that the input signal is sufficiently free from hum modulation. For example, a check may be made with either the signal source, the receiver or both supplied from batteries.

82. Presentation of the results

The hum can be expressed as a spectrum, or as the r.m.s. sum of the spectral components in decibels referred to a stated reference value. Curves may be plotted of hum output as a function of input signal level.

SECTION TWENTY-NINE — UNWANTED OSCILLATIONS

83. Unwanted self-oscillations

A receiver should be investigated for unwanted radio-frequency or intermediate-frequency self-oscillation with every possible combination of settings of the controls, except any combination specifically excluded by the manufacturer in the user instructions, and with or without an applied signal, an earth connection and antenna, and with different lengths of antenna, especially indoor antennas if permitted by the manufacturer, and loudspeaker and external audio-frequency input leads.

Anomalies in the performance under any of these conditions should be noted, due allowance being made for the likelihood of the combination of control settings in question being achieved in normal use.

Note. — In addition to instability, hum may be produced by the receiver with some abnormal combinations of control settings, for example, if a record-playing unit is included in the same case as the receiver, hum may be induced from the motor to a ferrite antenna but the motor would not normally be operating when the ferrite antenna was in use.

84. Unwanted electro-acoustic effects

Unwanted effects can be produced in electronic equipment as a result of mechanical vibration of components, including wiring. Such components are said to be "microphonic". The vibration may arise from an external source or from the loudspeaker used with the receiver.

85. Unwanted acoustic feedback

A circuit arrangement similar to that shown in Figure 9, page 105, is suitable for this measurement. The receiver is first brought under standard measuring conditions with the gain of the amplifier/attenuator combination A set to unity. The modulation is then removed, the volume control (if any) set at maximum and the receiver detuned slightly in each direction slowly in order to provoke acoustic self-oscillation if possible. The gain of the combination A is then varied until it is just possible to provoke acoustic self-oscillation, and the value of gain of the combination A noted.

The measurement may be repeated with other values of input signal level, and other input frequencies, particularly those which may be critical with respect to vibration of variable capacitors, for example between one-third and one-half rotation from the low-capacitance position.

Notes 1. — During the detuning process the receiver may be tapped to induce oscillation.

2. — If the receiver has a built-in loudspeaker, the nature of the surface on which the receiver stands, and the acoustic properties of the surroundings, may affect the results.

86. Presentation of the results

The results shall be expressed as the stability reserve against acoustic feedback which is equal to the voltage gain in decibels of the combination A.

CHAPTER VI: REJECTION OF ADDITIONAL MODULATION OF THE INPUT SIGNAL

SECTION THIRTY – REJECTION OF SUB-CARRIER MODULATION OTHER THAN THAT DUE TO THE STEREOPHONIC SIGNAL

87. **Introduction**

Broadcast stereophonic signals may include monitoring signals for use by the broadcasting authority and several types of additional subcarrier modulation, including, for example, special signals for traffic broadcasting and the so-called Subsidiary Communications Authorization (SCA) system. Receivers are required to reject these signals except when it is intended by the user that they should be received, and the receiver is operated in the appropriate special mode.

88. **Method of measurement of rejection of signals in the band 16 kHz to 22 kHz and 54 kHz to 75 kHz**

The receiver is brought under standard measuring conditions (Sub-clause 7.12) in the stereo mode. The modulation is then removed from one channel only. An additional monophonic modulation at ±7.5 kHz (±5 kHz) deviation of frequency variable between 16 kHz and 22 kHz or 54 kHz and 75 kHz is added to the composite signal. The output of the channel which has no 1 kHz modulation input is noted as the frequency of the additional signal is varied.

Measurements may be repeated at other values of input signal level, and at other values of deviation due to the additional signal. The deviation of the additional signal required to cause the stereo decoder to operate may also be measured at each frequency.

Note. – A special method for SCA rejection is given in Clause 90.

89. **Presentation of the results**

The results may be expressed as a spectrum or a table of output voltage or power expressed in decibels, as a function of frequency.

90. **Method of measurement for signals in the range 62 kHz to 73 kHz (SCA rejection)**

The receiver is first brought under standard measuring conditions and then the modulation is changed to a pilot tone of 19 kHz at 7.5 kHz deviation together with a 67 kHz sub-carrier at 7.5 kHz deviation, the sub-carrier itself being frequency-modulated at 2.5 kHz with 6 kHz deviation. This test signal is chosen because a modulation frequency of 2.5 kHz produces maximum interference in the normal programme channels. The output signals from the normal programme channels are measured. The measurement may be repeated at other input signal levels.

91. **Presentation of the results**

The output of each channel due to interference is expressed as a ratio in decibels referred to the output produced under standard measuring conditions but with 75 kHz deviation at 1 kHz.

CHAPTER VII: MISCELLANEOUS

SECTION THIRTY-ONE – RADIATION

92. Introduction

Receivers may radiate significantly at the frequency of the local oscillator, at the intermediate frequency and at their harmonics. The radiation may be propagated directly from the receiver, from the antenna or into the supply mains.

Measurement of radiation is dealt with in IEC Publication 106 to which reference should be made (see also C.I.S.P.R. Publication 13: Limits and Methods of Measurement of Radio Interference Characteristics of Sound and Television Receivers).

SECTION THIRTY-TWO – SUPPRESSION OF THE FUNDAMENTAL AND HARMONICS OF THE SUB-CARRIER AND THE PILOT TONE

93. Introduction

Ultrasonic frequencies may appear at the outputs of the receiver which may cause incorrect operation of the receiver itself, or of associated equipment, notably tape-recorders. These effects are minimized by designing the stereo decoder so as to suppress certain sub-carrier frequencies or by incorporating filters in the receiver, or both.

94. Method of measurement

The receiver is brought under standard measuring conditions and then the modulation is changed to pilot tone only. The residual output voltage is then measured, without using the filter of Sub-clause 6.2. Selective measurements, at the pilot-tone frequency and its harmonics, may also be made with 1 kHz modulation in phase opposition in the two channels and with a frequency deviation of ±22.5 kHz (±15 kHz). Measurements shall also be made at frequencies 1 kHz above and below multiples of the pilot-tone frequency in order to include sideband components.

Note. – The sideband components are usually of similar magnitude to that of the pilot-tone harmonic and should be measured with various modulation frequencies up to 15 kHz.

Measurements should be made at all sets of audio-frequency output terminals provided on the receiver.

95. Presentation of the results

The output of each channel due to the pilot-tone, sub-carrier, sideband and their harmonics is expressed as a ratio in decibels referred to the output produced under standard measuring conditions but with rated maximum system deviation at 1 kHz.

The results of selective measurements may be expressed as spectra.

SECTION THIRTY-THREE – SUPPRESSION OF INTERFERENCE DUE TO ADJACENT CHANNEL SIGNALS WITH A STEREOPHONIC RECEIVER USING THE PILOT-TONE SYSTEM

96. Introduction

Interference can be caused in a stereophonic receiver due to beats between a harmonic of the sub-carrier and a difference-frequency signal present in the output of the detector due to an adjacent channel signal. Restriction of the detector bandwidth by means of a low-pass filter, or a special decoding technique, or both, are required to suppress this interference.

Note. – This interference is also shown by the method of Clause 51.

97. Method of measurement

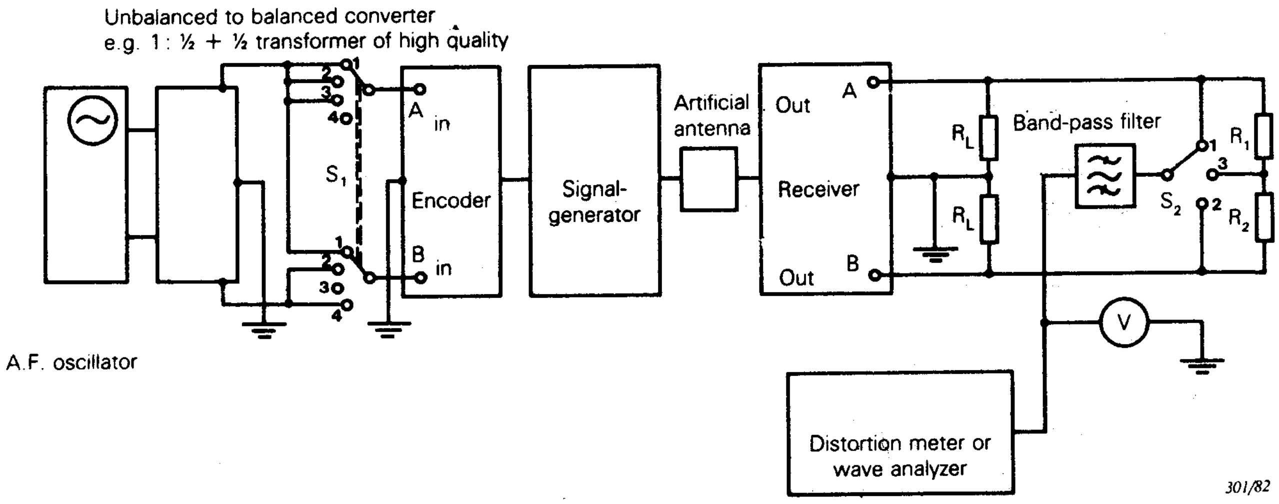
The receiver is brought under standard measuring conditions and then the modulation changed to pilot-tone only, a second signal also being applied in accordance with Clause 47 of IEC Publication 315-1. This second signal is unmodulated and its frequency separation from the first input signal is adjusted to $\pm(38\,n + 1)$ kHz where n is an integer greater than 2. Beats resulting from these frequencies and harmonics of the sub-carrier will thus be at a frequency of 1 kHz, and the level of the second signal is adjusted to produce an audio-frequency output 30 dB below that which would be produced under standard measuring conditions but with deviation equal to rated maximum system deviation. This latter level may not be achievable due to overloading but may be easily calculated.

98. Presentation of the results

The level of the interfering signal is tabulated for each value of frequency difference.

SECTION THIRTY-FOUR – SENSITIVITY, ANTENNA GAIN AND DIRECTIONAL RESPONSE OF ROD, TELESCOPIC AND BUILT-IN ANTENNAS

Under consideration



R_1 and R_2 = balancing resistors $R_2 \gg R_L$.
R_L = audio-frequency substitute load resistors.
Filter input impedance $\gg R_2$.

For band-pass filter characteristics, see Sub-clause 6.2 and Figure 1a.

For artificial antennas, see Sub-clause 7.10 and IEC Publication 315-1.

FIG. 1. — Schematic circuit arrangement for measuring fidelity.

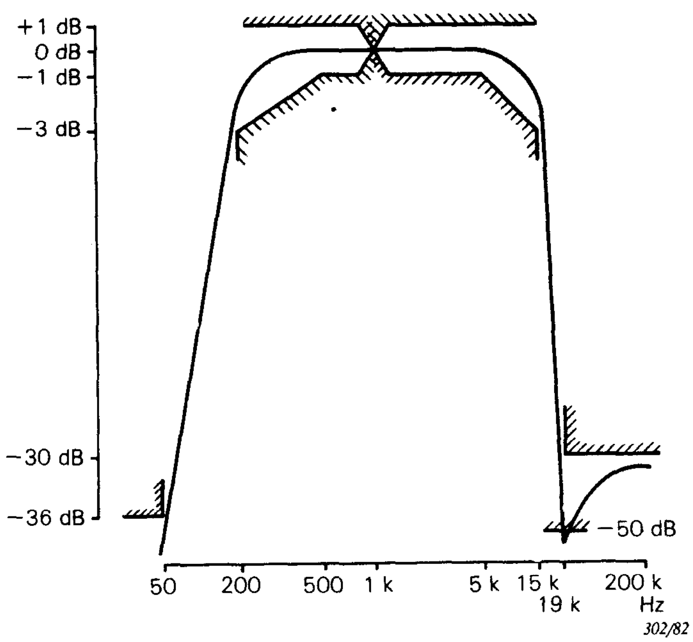


FIG. 1a. — Frequency response limits of band-pass filter (200 Hz to 15 kHz) (see Sub-clause 6.2).

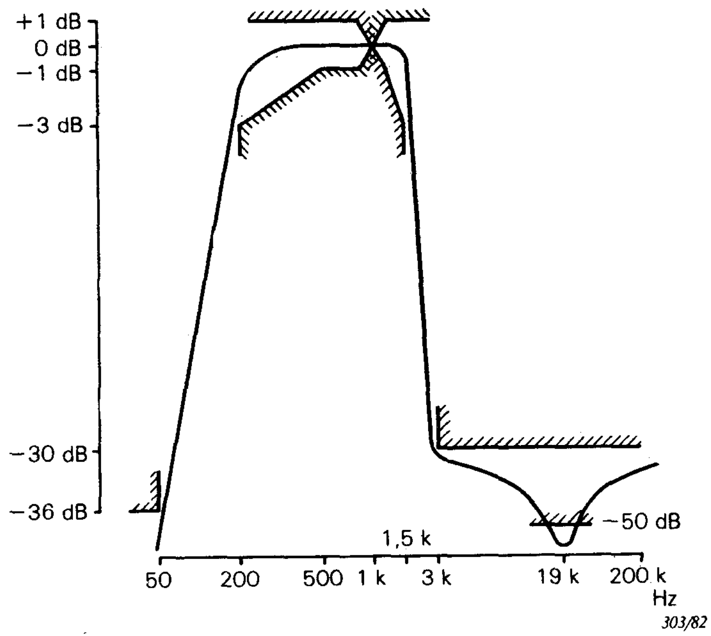


FIG. 1b. — Frequency response limits of band-pass filter (200 Hz to 1.5 kHz) (see Sub-clause 51.1).

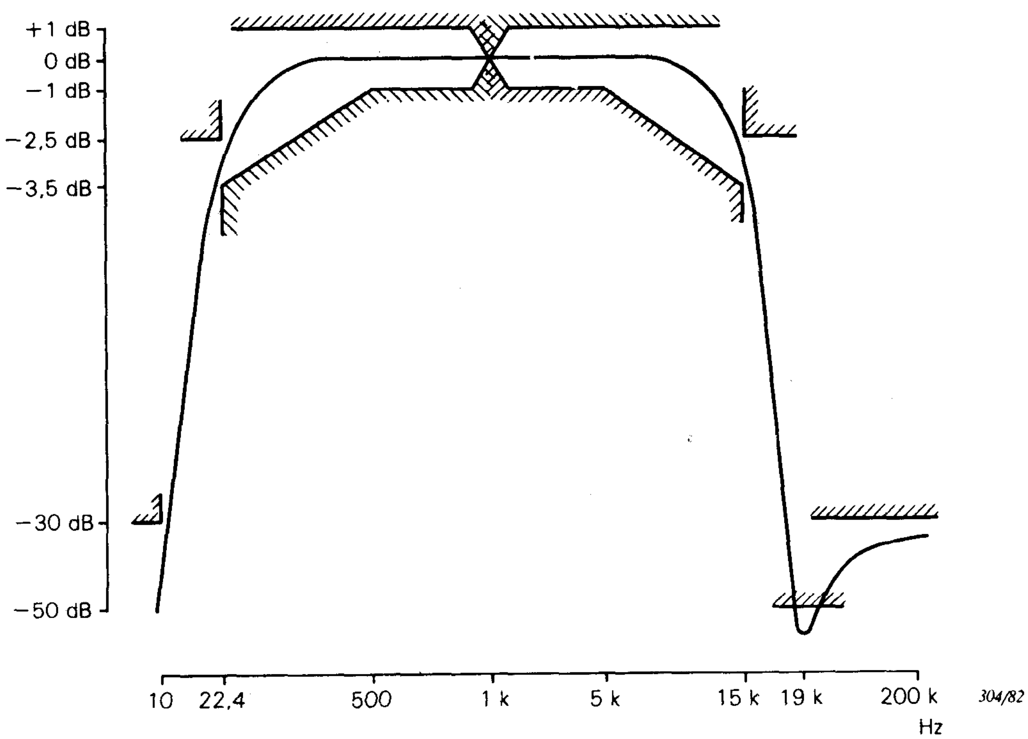


FIG. 1c. — Frequency response limits of band-pass filter 22.4 Hz to 15 kHz) (see Sub-clause 66.3).

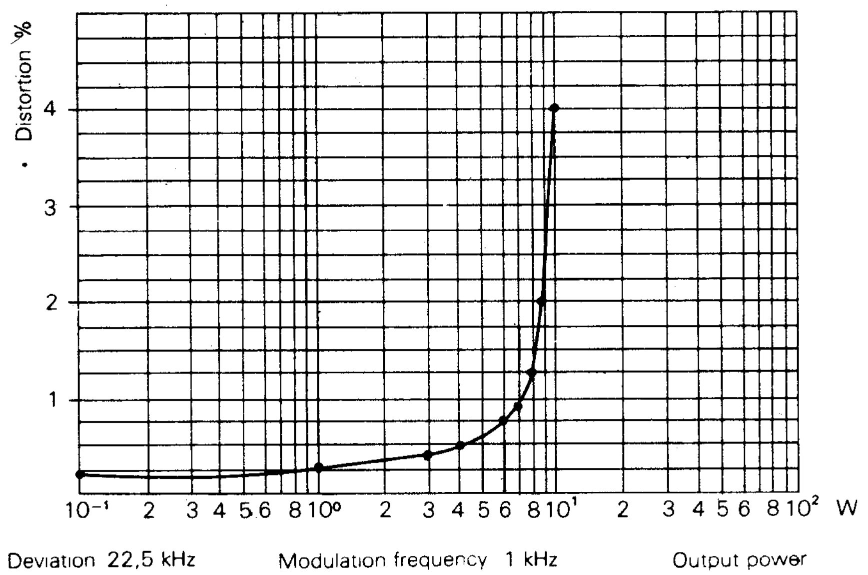


FIG. 2. — Overall total harmonic distortion as a function of output power (see Clause 11).

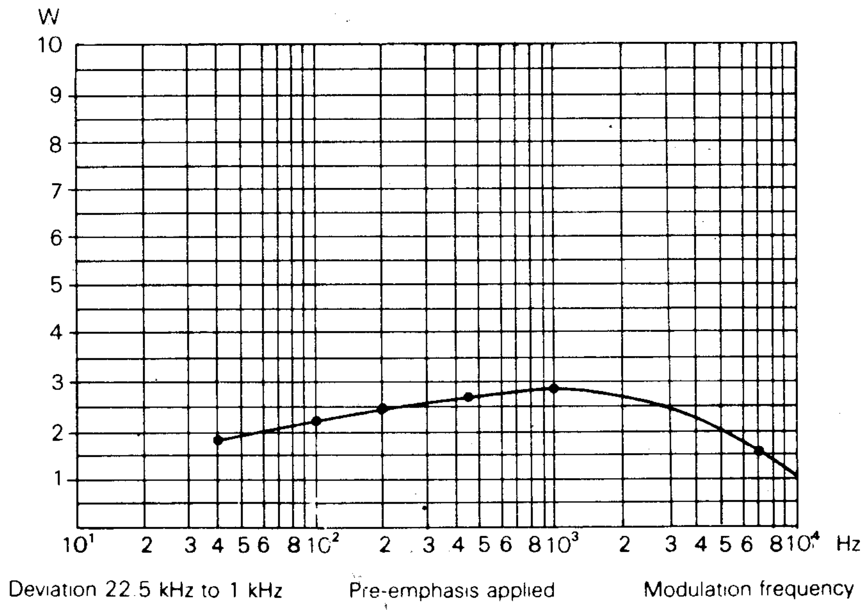
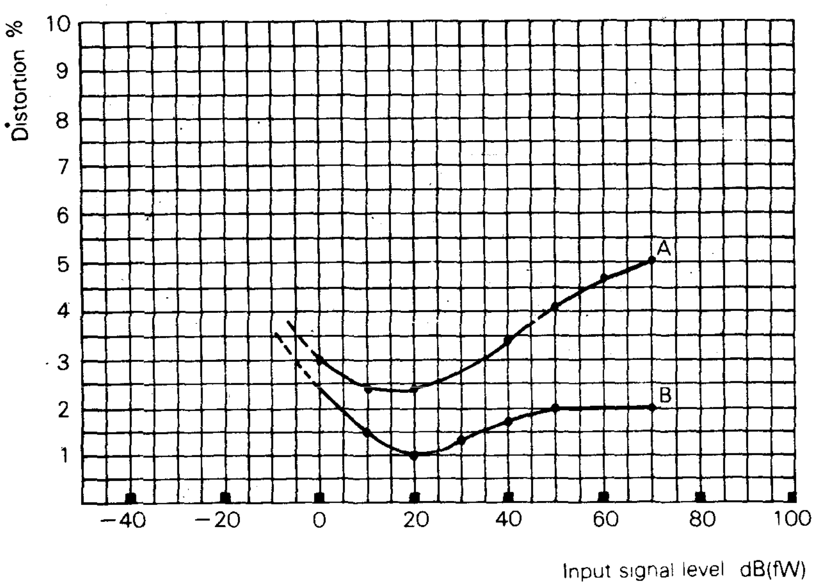
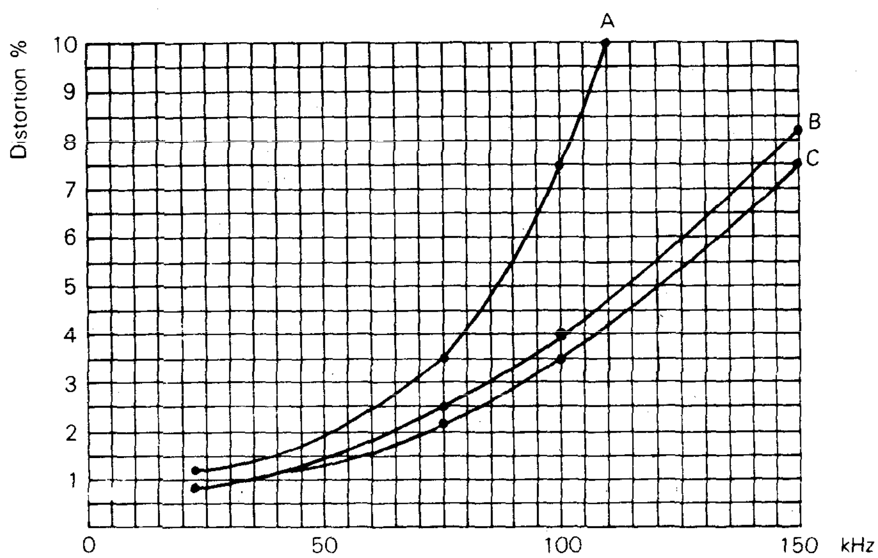


FIG. 3. — Distortion-limited output power as a function of modulation frequency (see Clause 11).



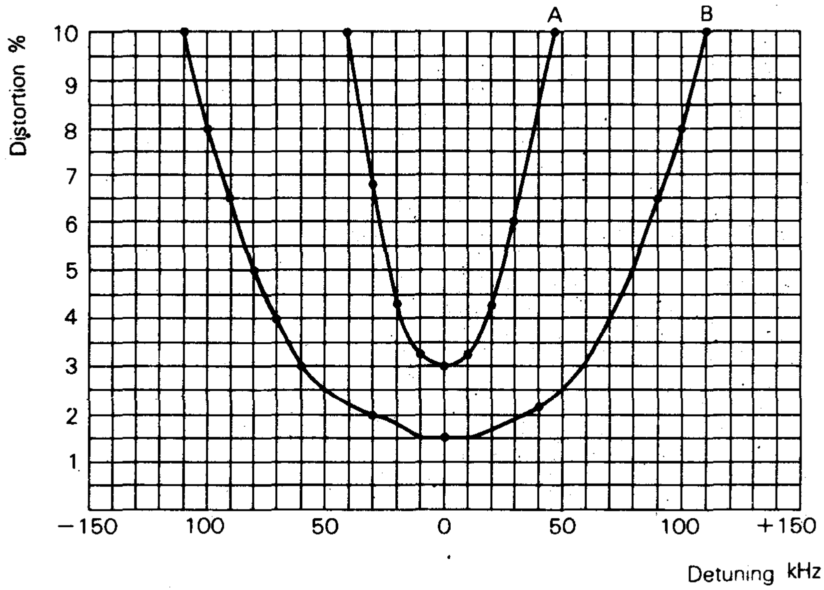
A = 50 kHz deviation
B = 15 kHz deviation

FIG. 4. — Harmonic distortion as function of input signal level (see Clause 14).



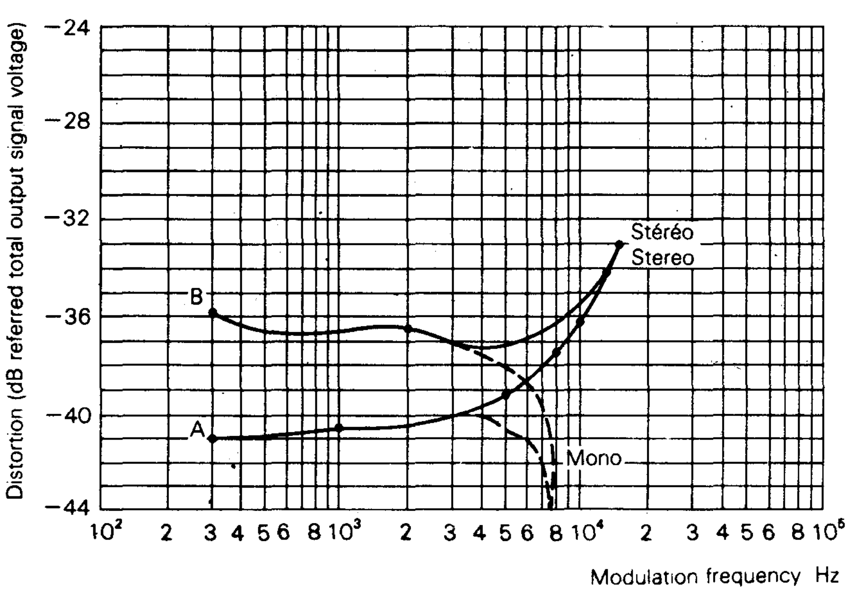
A = input level signal 10 dB(fW)
B = input level signal 20 dB(fW)
C = input level signal 40 dB(fW)

FIG. 5. — Distortion as a function of the deviation (see Clause 17).



A = 300 dB(fW)
B = 70 dB(fW) deviation ± 75 kHz

FIG. 6. — Variation of distortion arising from inaccuracy of tuning (see Clause 20).



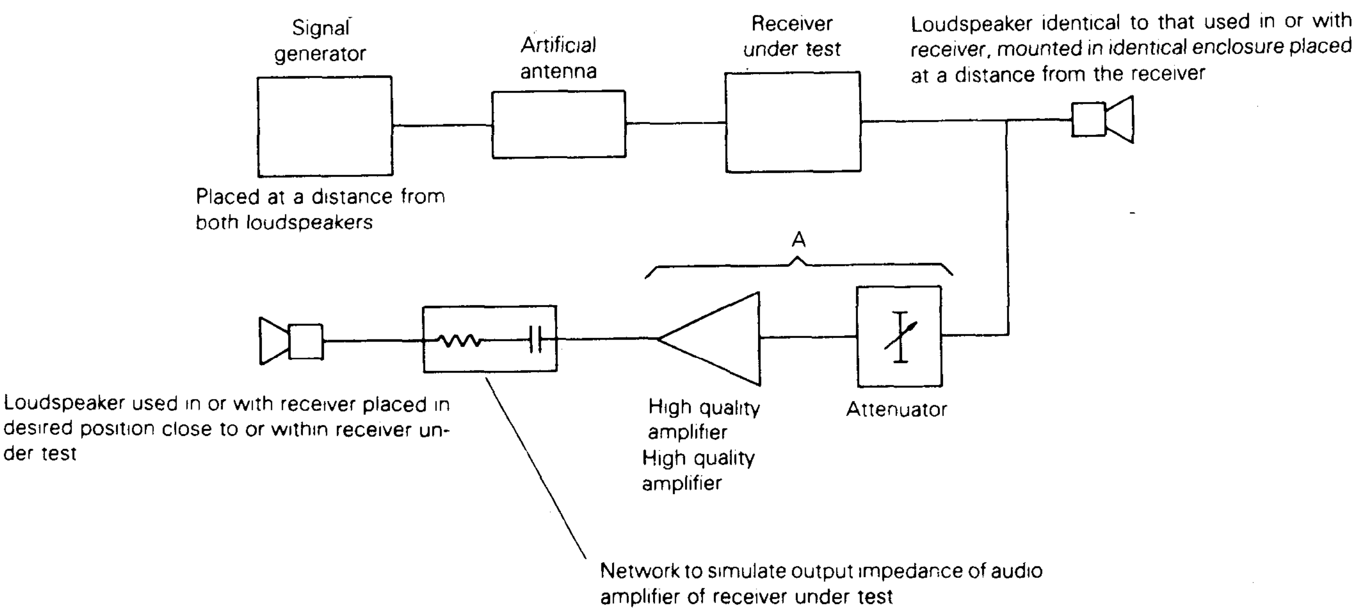
A = ± 22.5 kHz deviation
B = ± 75 kHz deviation

FIG. 7. — Harmonic distortion as a function of the audio-frequency modulation frequency (see Clause 23).

Output frequency (kHz)	Type of response	Response (dB)
1.6	×	−35
1.8	0	−45
2.3	0	−36
3.0	×	−40
3.1	0	−43
3.2	□	−35
5.0	□	−40
6.0	□	−50
6.2	×	−45
6.4	0	−40
7.8	0	−45

0 = intermodulation between channel signals.
× = intermodulation between one channel signal and 19 kHz.
□ = intermodulation between one channel signal and 38 kHz.
Left-hand channel only. 0 dB = output produced by standard radio-frequency input signal.
Left channel input frequency 8.7 kHz. ±33.75 kHz deviation.
Right channel input frequency 11.0 kHz. ±33.75 kHz deviation.

FIG. 8. — Cross-intermodulation between the channels of a stereo receiver (see Clause 29).



Note. — The attenuator input impedance shall be high compared to the output impedance of the receiver under test and of the loudspeaker.

FIG. 9. — Measurement of acoustic feedback (see Clause 85).

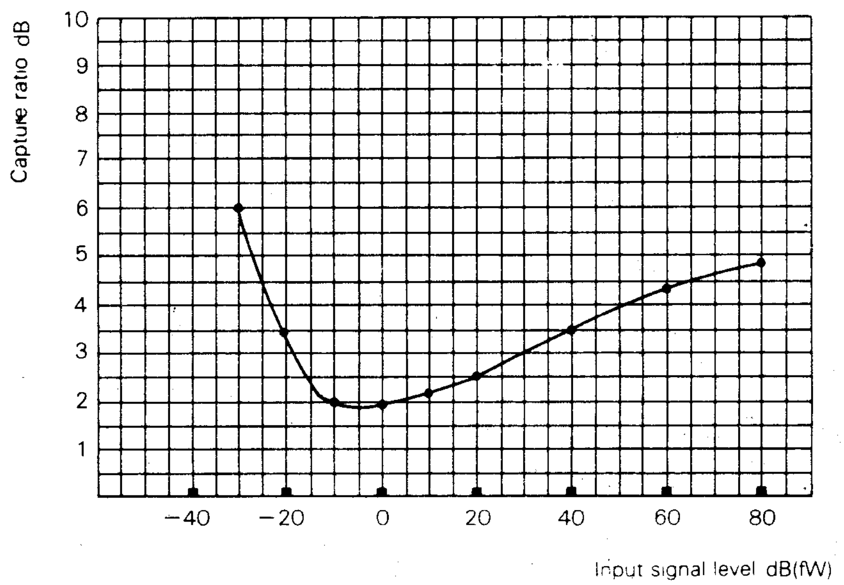
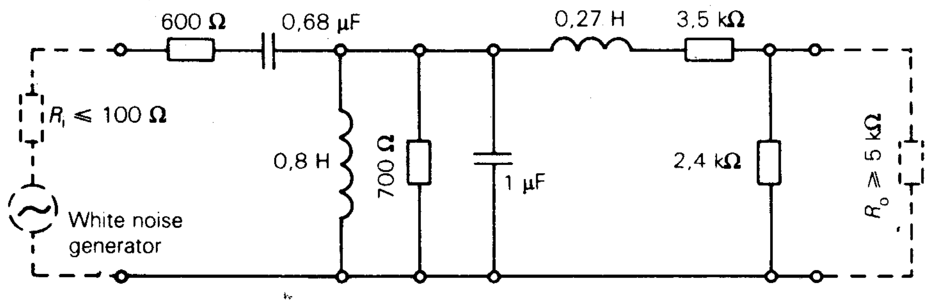
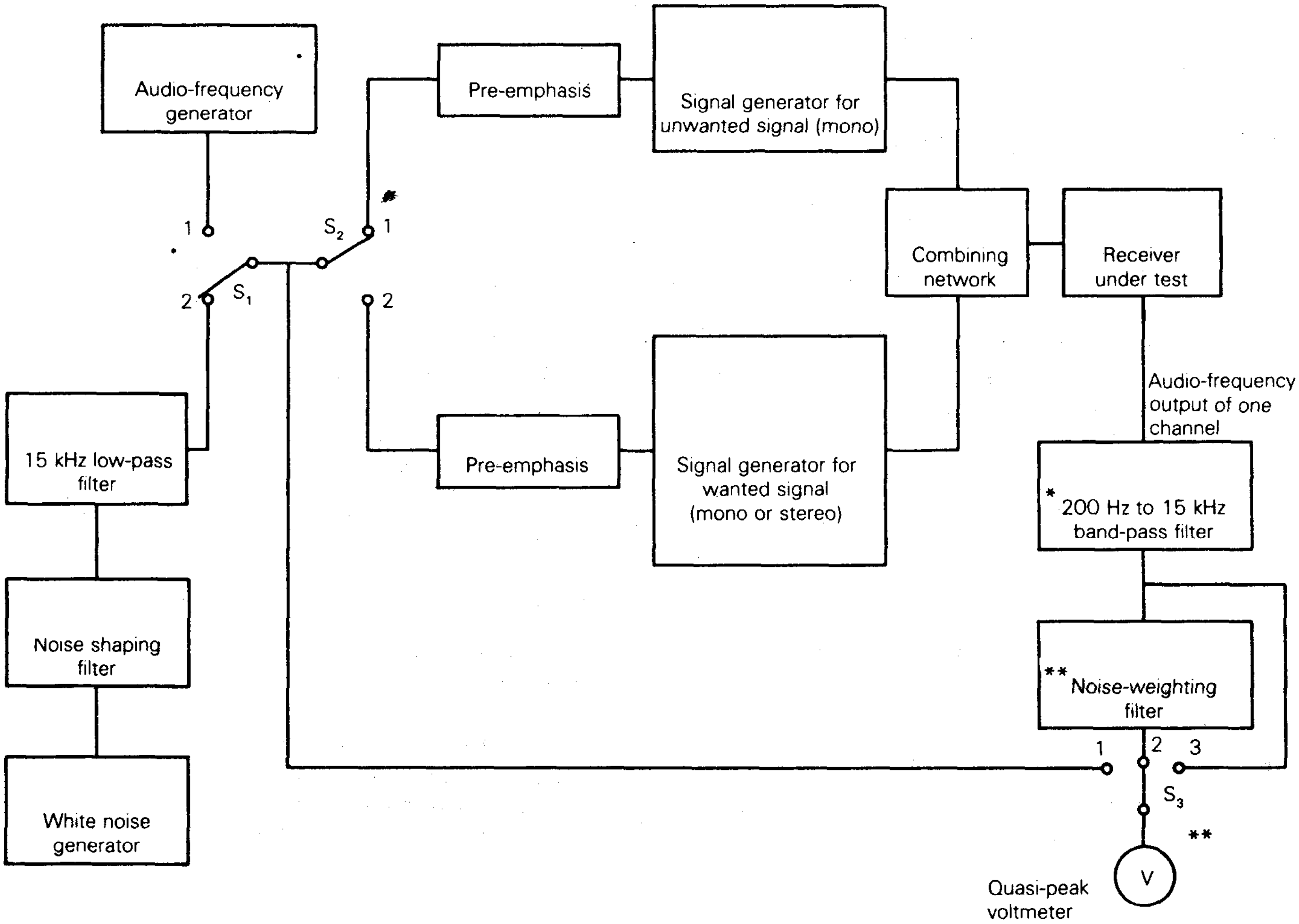


FIG. 10. – Capture ratio (see Clause 48).



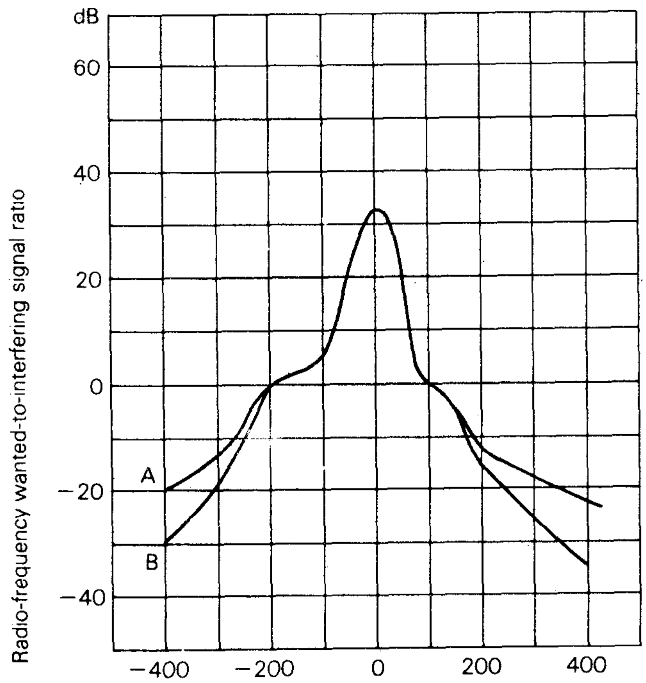
(White noise of bandwidth 10 Hz to 15 kHz is attenuated by 32 dB.)

FIG. 11. — Circuit arrangement to convert white noise into special weighted noise for adjacent-channel rejection measurements (see Sub-clause 51.1).



* See Figure 1a, page 101.
** See Appendix A.

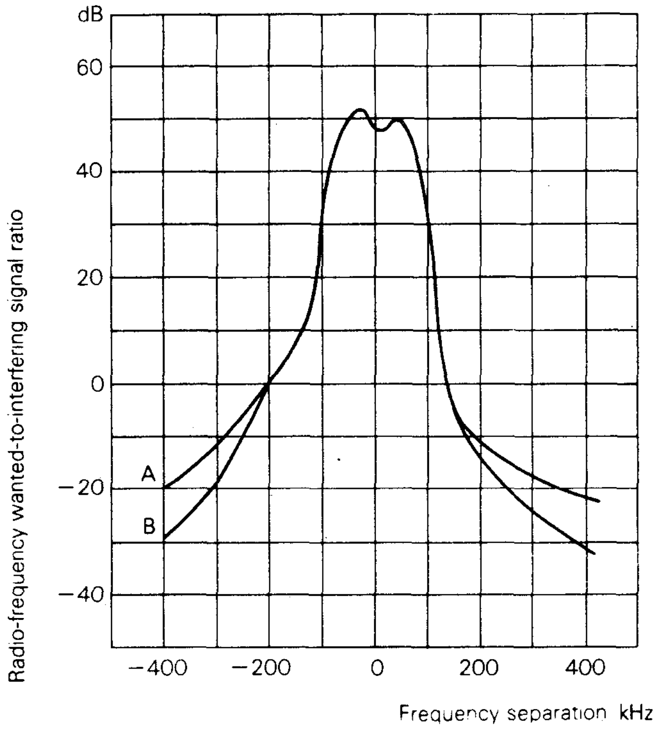
FIG. 12. — Arrangement for measuring rejection of unwanted signals using noise modulation (see Sub-clause 51.1).



Curve A = 50 dB(fW) } available power of
Curve B = 30 dB(fW) } the wanted signal

FIG. 13a. — Selectivity curves (mono) (see Clause 52).

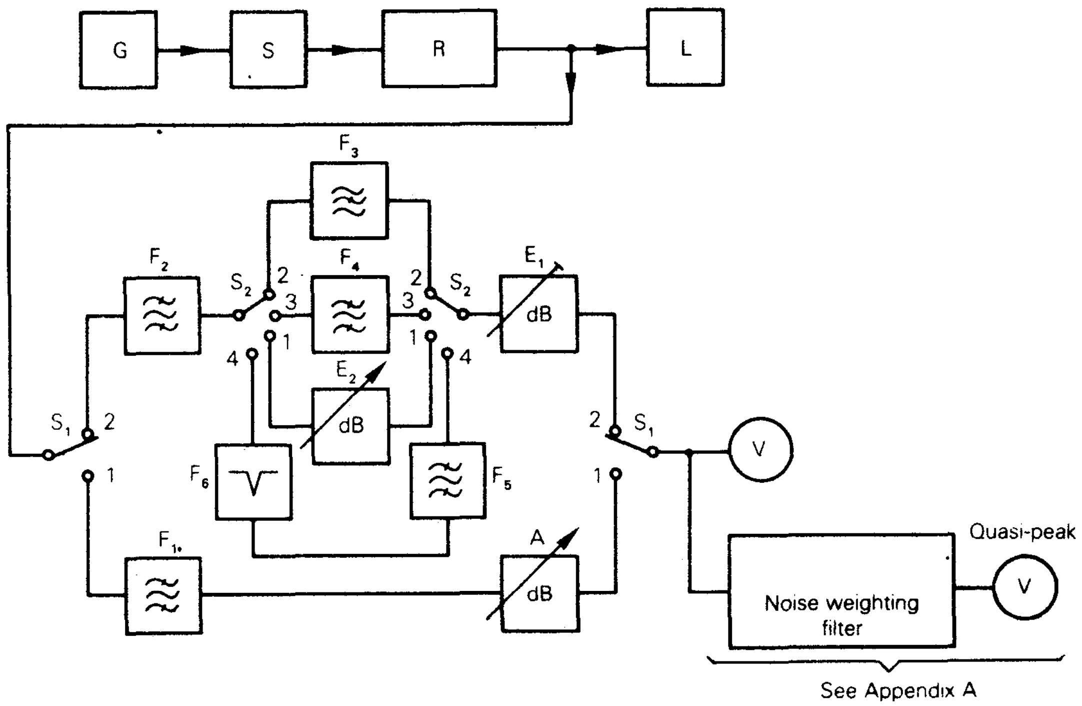
Figure 13 continued on facing page.



Curve A = 50 dB(fW) } available power of
Curve B = 30 dB(fW) } the wanted signal

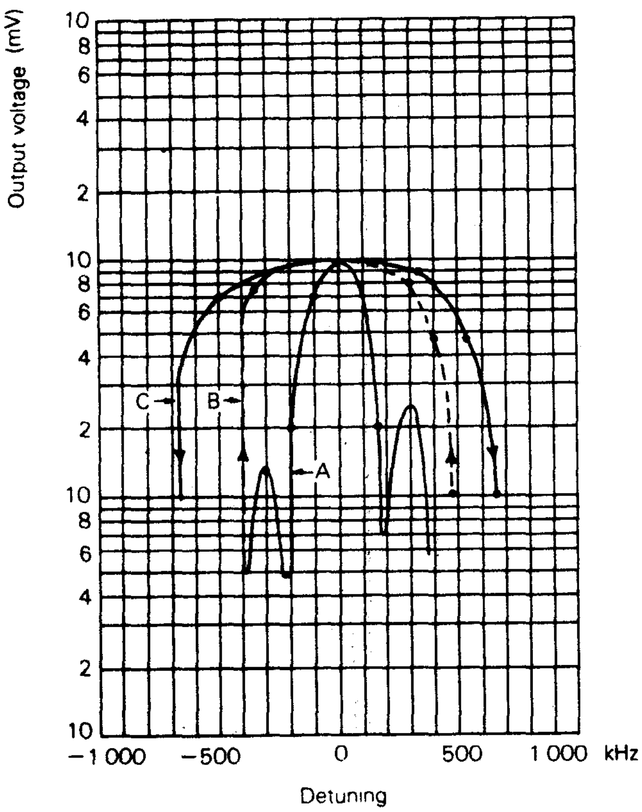
FIG. 13b. — Selectivity curves (stereo) (see Clause 52).

FIG. 13. — Audio-frequency signal to interference ratio = 50 dB (quasi-peak, weighted, referred to ±75 kHz deviation).



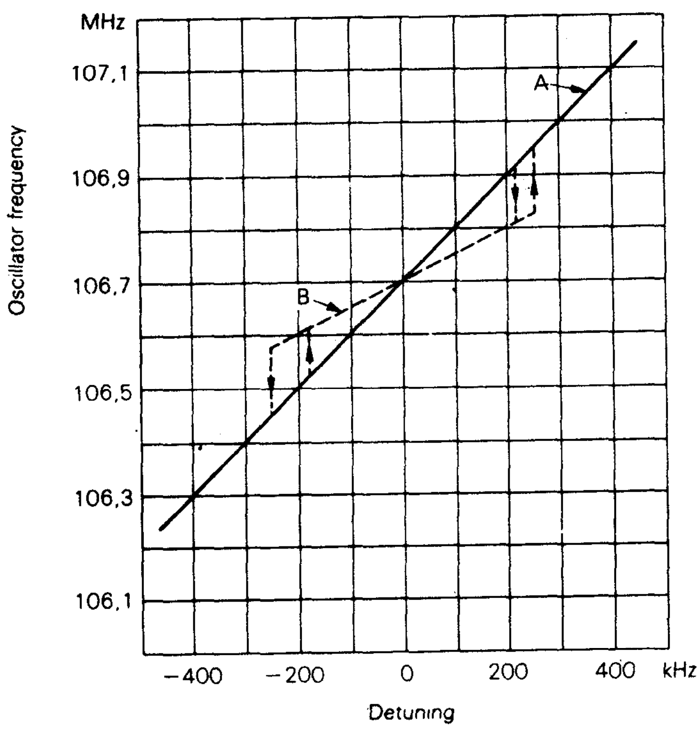
G = standard signal generator (see Sub-clause 7.9)
S = artificial antenna
R = receiver
L = substitute load
F_1 = narrow band-pass filter for standard reference frequency (e.g. ⅓-octave)
F_2 = band-pass filter from 200 Hz to 15 kHz (see Figure 1a, page 101)
F_3 = narrow band-stop filter for standard reference frequency
E_1 = pre-set attenuator to equalize the losses in the two branches
E_2 = attenuator to equalize the loss of the filters
V = voltmeter, calibrated r.m.s. voltage appearing at audio-frequency substitute load
A = attenuator
F_4 = narrow band-pass filter for standard reference frequency (e.g. ⅓ octave) (see Sub-clause 66.2)
F_5 = band-pass filter from 200 Hz to 1.5 kHz (see Figure 1b, page 101) (see Sub-clause 54.1)
F_6 = adjustable notch filter for 1 kHz (see Sub-clause 54.1)

FIG. 14. — Circuit arrangement for various measurements.



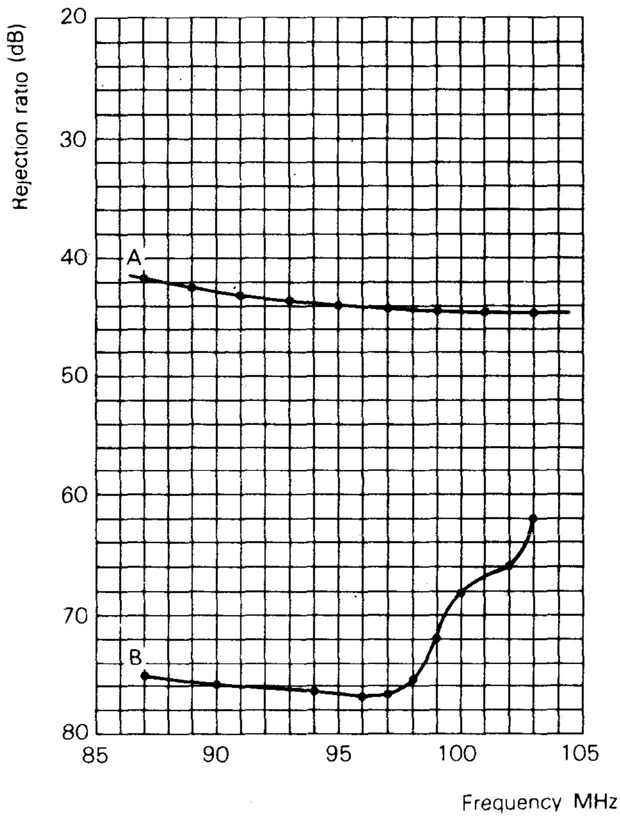
A = without automatic frequency control
B = pull-in range with automatic frequency control
C = holding range with automatic frequency control

FIG. 15. — Tuning characteristic (see Clause 56).



A = without automatic frequency control
B = with automatic frequency control

FIG. 16. — Tuning characteristic obtained by measuring the oscillator frequency (see Clause 57).



A = image frequency rejection (single-signal method)
B = intermediate frequency rejection (single-signal method)

FIG. 17a. — Image and intermediate frequency rejection ratio (see Clause 60).

Frequency (MHz)	Response (dB)
94,0	0
99,35	−40
88,65	−45
101,1	−55
86,9	−60
115,4	−37

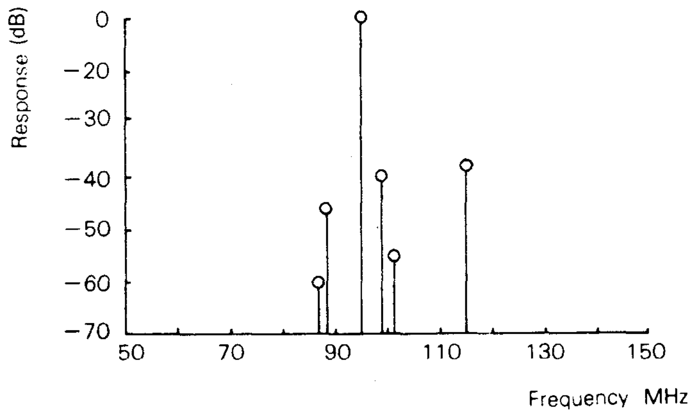
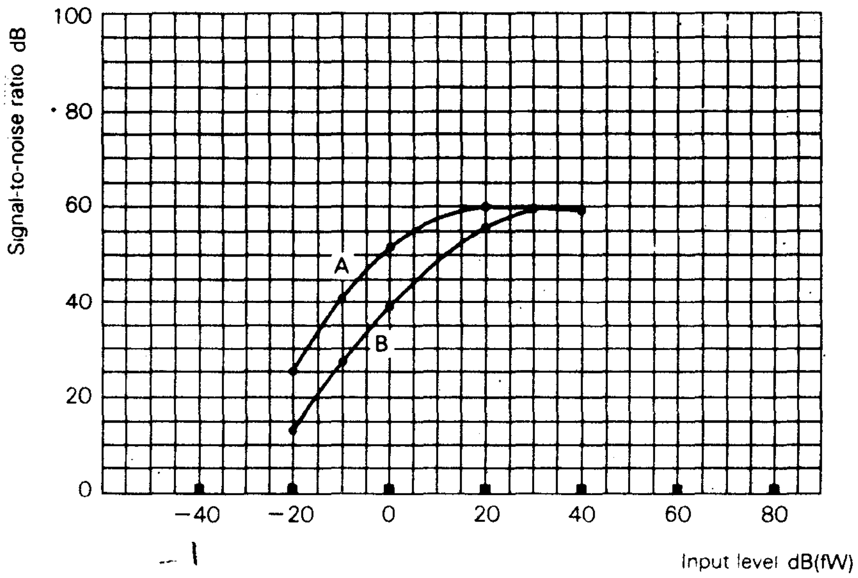
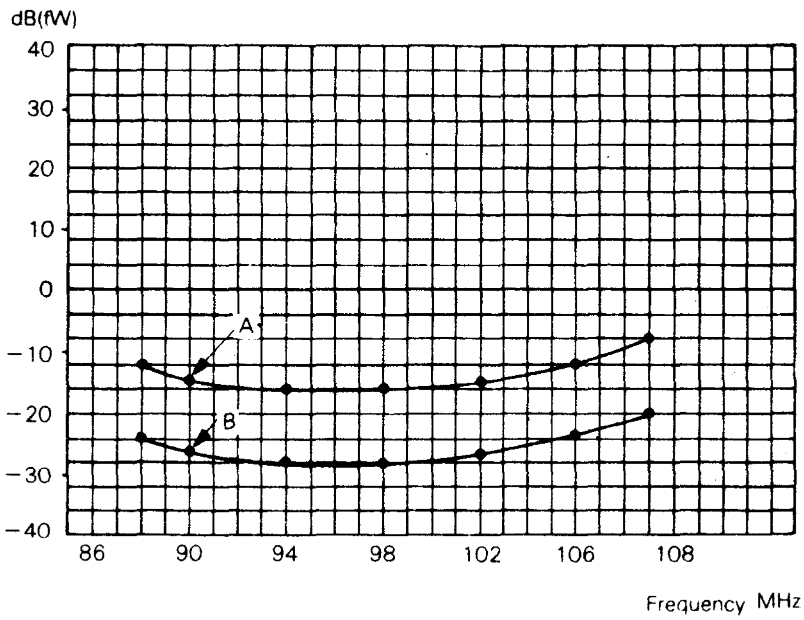


FIG. 17b. — Spurious responses at a tuning frequency of 94 MHz (single-signal method) (see Clause 60).



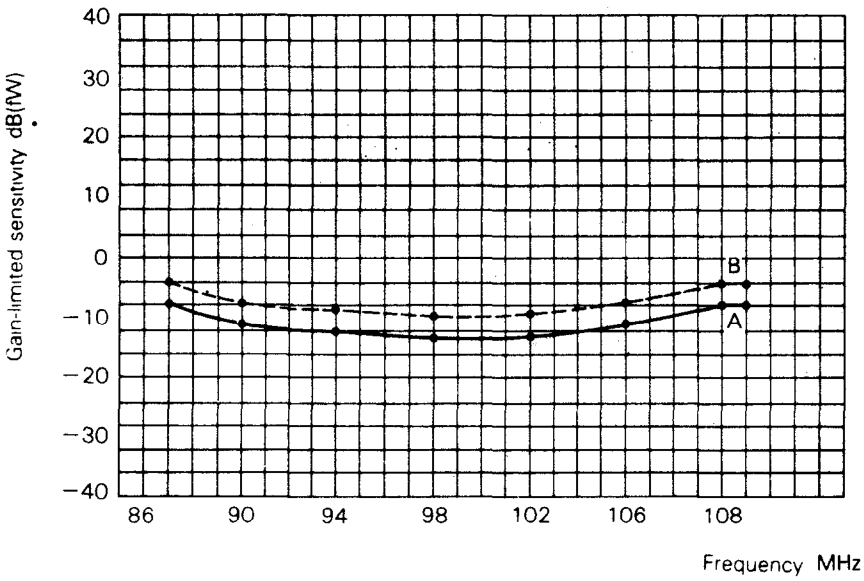
A = mono
B = stereo } method of Sub-clause 66.1

FIG. 18. — Signal-to-noise ratio (see Clause 67).



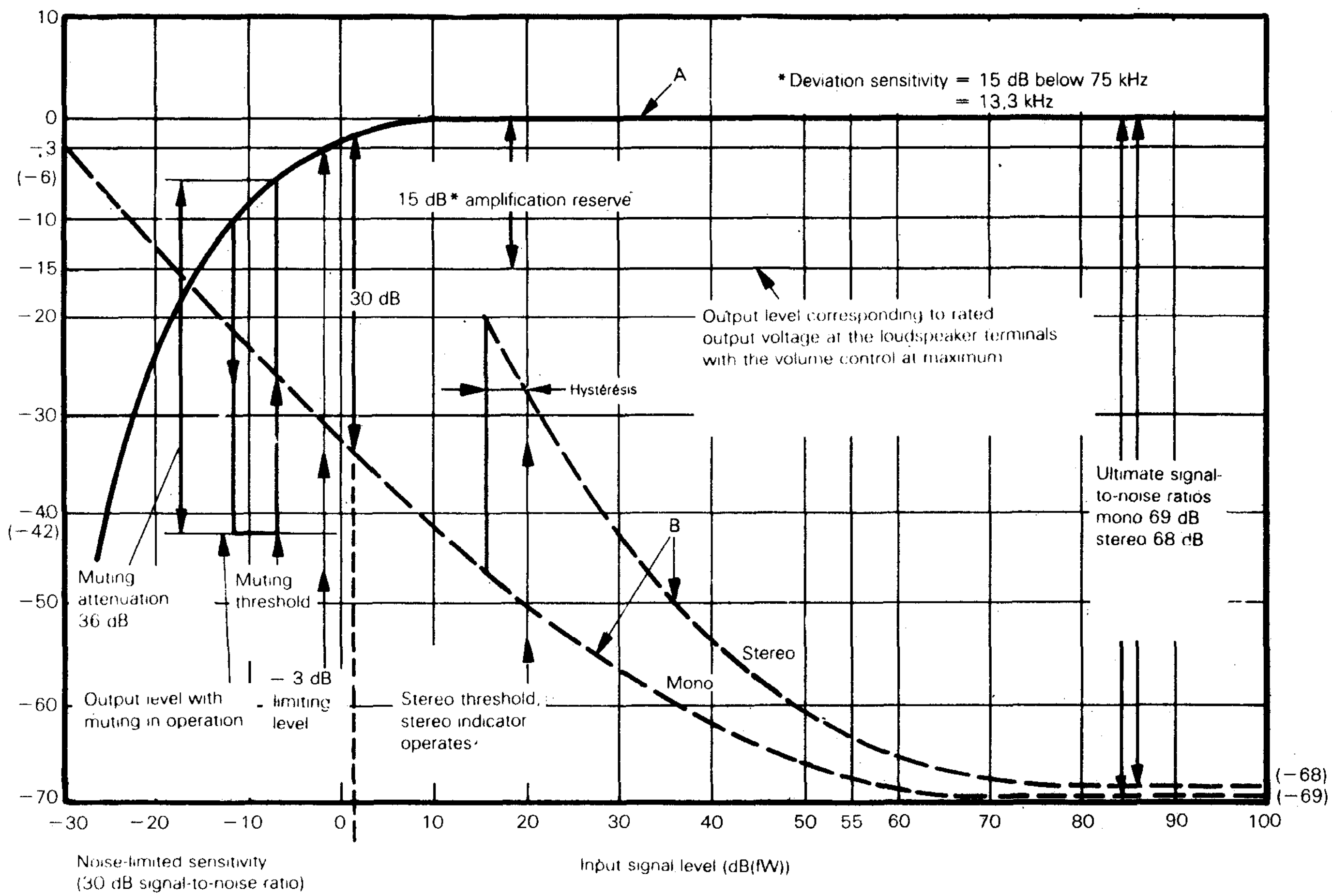
A = signal-to-noise ratio: 30 dB } method of
B = signal-to-noise ratio: 20 dB } Sub-clause 66.1

FIG. 19. — Noise-limited sensitivity (see Clause 70).



A = mono
B = stereo

FIG. 20. — Gain-limited sensitivity as a function of signal frequency (see Clause 73).



Measured at the low-level audio output terminals.

A = signal output (± 75 kHz deviation)
B = noise output

FIG. 21. — Output/input characteristic (and noise output curves) showing terms explained in Clauses 72 to 77.

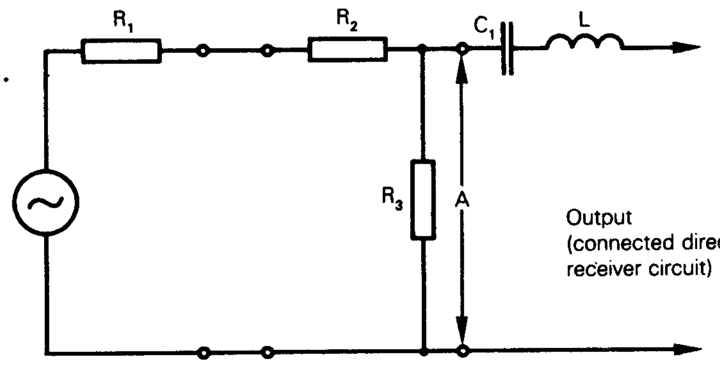


FIG. 22a. — For rod or telescopic antennas (approximately ¼ wavelength).

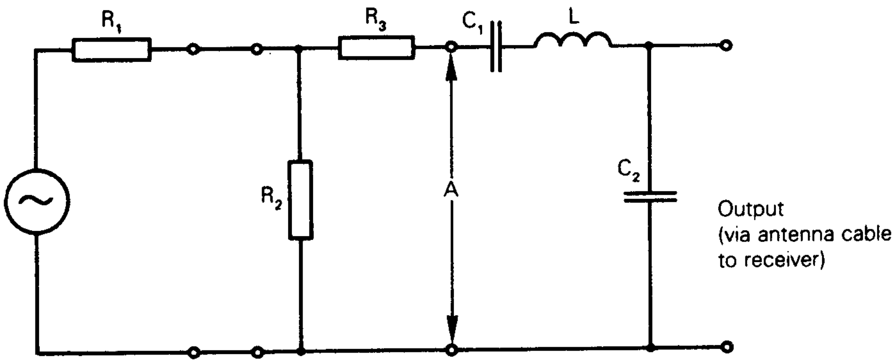


FIG. 22b. — For car radio antennas.

FIG. 22. — Circuits for unipole antennas (see Sub-clause 7.10.2).

APPENDIX A

NOISE WEIGHTING NETWORK AND QUASI-PEAK VOLTMETER

This weighting network and voltmeter are in accordance with C.C.I.R. Recommendation 468-2.

A1. Weighting network

The nominal response curve of the weighting network is defined together with the theoretical response of the passive network in Figure A2, page 121. Table AI gives the values of this response at various frequencies.

The permissible differences between the response curve of measuring networks and this nominal curve are shown in the last column of Table AII and in Figure A3, page 121.

TABLE AI

Frequency (Hz)	Response (dB)	Tolerance (dB)
31.5	−29.9	±2.0
63	−23.9	±1.4
100	−19.8	±1.0
200	−13.8	±0.85 [1)]
400	− 7.8	±0.7 [1)]
800	− 1.9	±0.55 [1)]
1 000	0	±0.5
2 000	+ 5.6	±0.5 [1)]
3 150	+ 9.0	±0.5 [1)]
4 000	+10.5	±0.5 [1)]
5 000	+11.7	±0.5
6 300	+12.2	0
7 100	+12.0	±0.2 [1)]
8 000	+11.4	±0.4 [1)]
9 000	+10.1	±0.6 [1)]
10 000	+ 8.1	±0.8 [1)]
12 500	0	±1.2 [1)]
14 000	− 5.3	±1.4 [1)]
16 000	−11.7	±1.65 [1)]
20 000	−22.2	±2.0
31 500	−42.7	+2.8 [1)] −∞

[1)] This tolerance is obtained by a linear interpolation on a logarithmic graph on the basis of values specified for the frequencies used to define the mask, i.e. 31.5 Hz, 100 Hz, 1 000 Hz, 5 000 Hz, 6 300 Hz and 20 000 Hz.

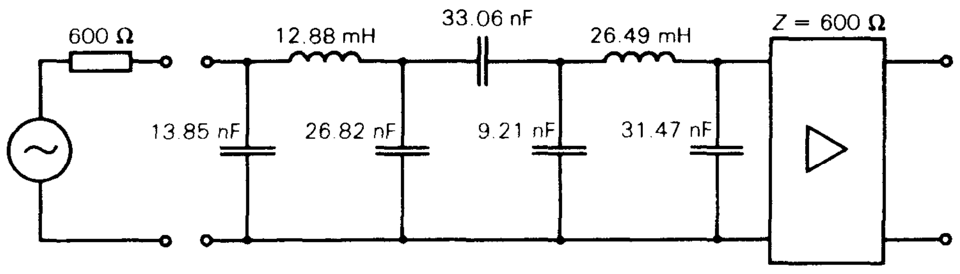
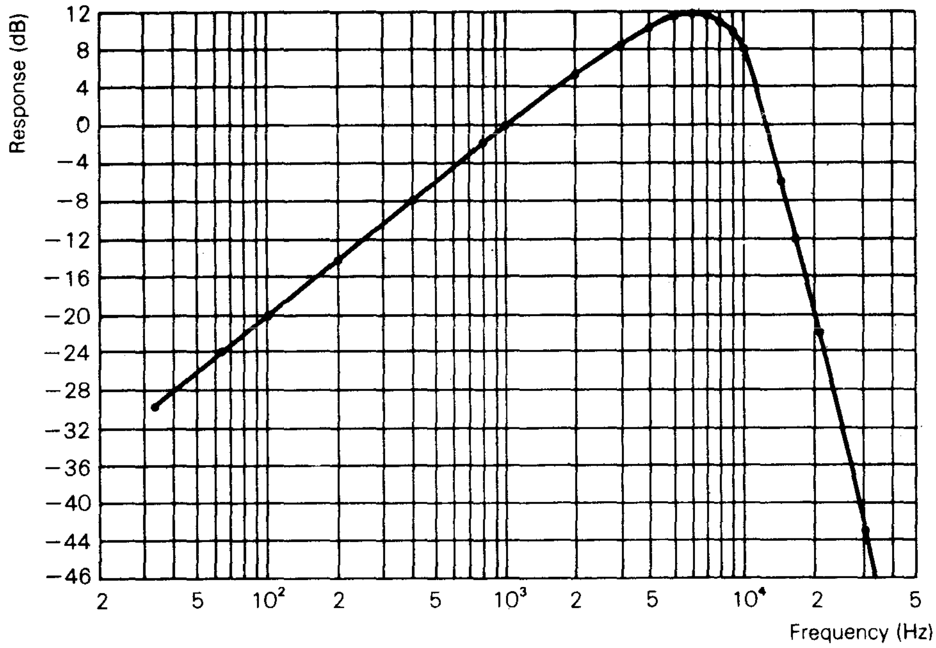


FIG. 23. — Weighting network.

328/82



(A tolerance of at most 1% on the component values and a *Q*-factor of at least 200 Hz at 10 000 Hz are sufficient to meet the tolerances given in Table AI.)

FIG. 24. — Frequency response of the weighting network shown in Figure A1.

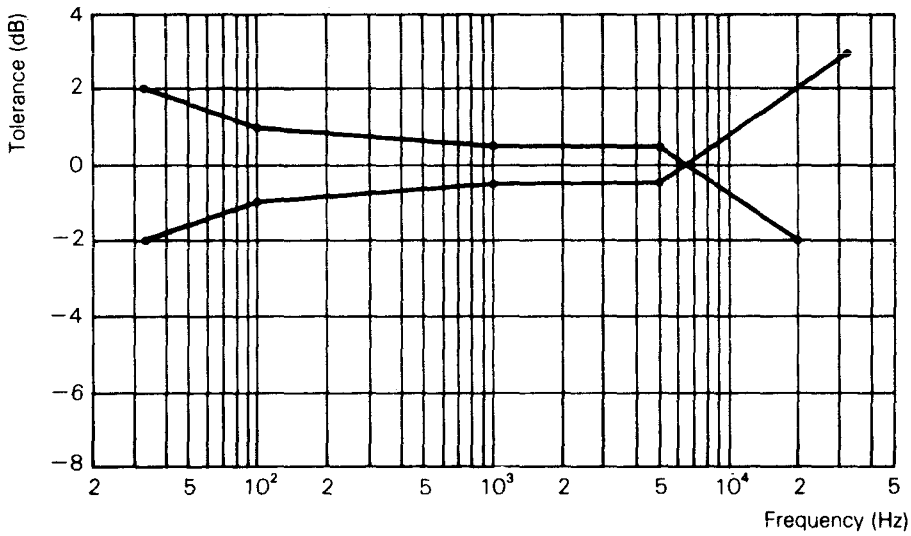


FIG. 25. — Maximum tolerances for the frequency response of the weighting network alone.

Notes 1. — The instrument as a whole is calibrated at 1 kHz.

2. — In order to improve the accuracy of measurement of signals with strong components near 6 kHz, a closer tolerance (e.g. ±0.2 dB) on the frequency response of the network at 1 kHz is desirable.

A2. Characteristics of the measuring device

A quasi-peak value method of measurement should be used. It is defined by the time-response characteristic of the measuring set, as described in Table AII.

TABLE AII

Burst duration (ms)[1]	1	2	5	10	20	50	100	200
Percentage of steady signal reading (%)	17.0 (−15.4 dB)	26.6 (−11.5 dB)	40 (−8.0 dB)	48 (−6.4 dB)	52 (−5.7 dB)	59 (−4.6 dB)	68 (−3.3 dB)	80 (−1.9 dB)
Limiting values (%):								
− lower limit	13.5 (−17.4 dB)	22.4 (−13.0 dB)	34 (−9.3 dB	41 (−7.7 dB)	44 (−7.1 dB)	50 (−6.0 dB)	58 (−4.7 dB)	68 (−3.3 dB)
− upper limit	21.4 (−13.4 dB)	31.6 (−10.0 dB)	46 (−6.6 dB)	55 (−5.2 dB)	60 (−4.4 dB)	68 (−3.3 dB)	78 (−2.2 dB)	92 (−0.7 dB)

[1] Method of measurement: A single burst of a 5 000 Hz sine-wave of a known duration is applied to the input of the instrument. The amplitude of the burst should correspond to about two-thirds of the reading scale. Table AII shows as a function of their durations, the limit values between which the reading shall fall; these values are expressed in percentages of the reading obtained for a steady signal of the same amplitude.

The dynamic properties of the device are further defined by the following procedure:

- a series of bursts of a 5 000 Hz sine-wave is applied to the input of the instrument, with a repetition frequency of 10 Hz and a burst duration of 5 ms. The amplitude of the burst should correspond to approximately two-thirds of the reading scale. The reading should reach 70% to 90% of the value corresponding to a steady signal of the same amplitude. This applies to all measurement ranges;

- the overload capacity of the whole chain preceding the reading device should be at least 20 dB in relation to the maximum indication of the scale. This condition applies to all ranges of sensitivity.

Amendment

No. 1
February 1989

Page 9

2. **Scope**

On page 17 amend the first sentence of Note 4 to read:

See Sub-clause 7.8.

Page 10

5. **Rated values**

Amend the title as follows:

5. **Rated values (IEV 151-04-03*)**

Applies to French text only.

5.1 *Rated conditions*

In the 5th line, amend "Sub-clause 6.2" *to* "Sub-clause 6.1".

---

* International Electrotechnical Vocabulary (IEV) [IEC Publication 50(151)], Chapter 151: Electrical and magnetic devices.

Page 14

7.10.1 *Balanced inputs*

Amend the first sentence of the second paragraph to:

Where a balanced source is not available, a "balun" transformer may be used, its insertion loss being allowed for.

Page 15

7.11.2 *Preferred tuning method*

Amend the first sentence to:

If the receiver has a tuning indicator, the receiver shall be tuned in accordance with the manufacturer's instructions on the use of the indicator: this corresponds to the way that the receiver is tuned when in use.

7.12 *Standard measuring conditions*

On page 16, amend Item e) to:

e) The volume control (if any) is adjusted so that the output voltage at the main audio-frequency output terminals is 10 dB below the rated distortion-limited output voltage. Measurements may also be made at other stated values of output voltage or power;

Page 16

Replace in last line letter "k" by "j".

Page 18

Section five - Overall distortion as a function of input power

12. **Introduction**

Applies to French text only.

Page 24

32.1 *Overall stereophonic identicality factor*

Amend the first paragraph to:

The receiver is brought under standard measuring conditions in a circuit arrangement as shown in Figure 1, page 52, with S_1 in position 2 and S_2 in either position 1 or 2. Then S_2 is switched to position 3 and where a balance control or equivalent arrangement is provided, this is adjusted for minimum indication on the meter Next, meter readings are noted with S_1 in position 1 and S_1 in position 2. The overall stereophonic identicality factor is then

Page 29

Section Sixteen - Capture ratio

47. **Method of measurement**

In line 8, amend "30 dB(pW)" *to* "60 dB(fW)".

Page 31

51. **Method of measurement using noise modulation**

On page 61, in the fourth line of the second paragraph of Sub-clause 51.4, amend "switch 3" *to* "switch S3"

Page 34

Section Twenty - Rejection of unwanted signals entering through the antenna

58. **Introduction and explanation of terms**

On page 67, (in the first line of Item 2), correct spelling of "absence".

Page 37

Section Twenty-one - Spurious responses caused by strong signals

63. **Introduction**

In the fourth line, amend "(Sub-clause 63.4)" *to* "(Sub-clause 63.3)".

Page 43

Section Twenty-six - Output/input characteristic

75. **Method of measurement**

In the second line, amend "(Sub-clause 7.13)" *to* "(Sub-clause 7.12)", *and in the fourth line amend* "-30 dB(fW)" *to* "0 dB(fW)".

Page 44

77. **Explanation of terms**

Amend the fifth paragraph to:

> The *stereo threshold* is the input signal level at which the stereo decoder begins to operate: with the pilot-tone system a marked increase in noise is usual at this signal level unless the receiver includes a circuit which automatically increases the crosstalk between the audio channels at low input signal levels: this reduces the noise, which is in antiphase in the audio channels, by cancellation.

Page 53

Figure 1b

Replace in title:

"(see Sub-clause 51.1)" *by* "(see Sub-clause 54.1)".

Page 55

Figure 4

Increase all abscissa values by 30 dB. (For example, -30 dB(fW) becomes 0 dB(fW)).

Figure 5

Replace the caption by:

A = input signal level 40 dB(fW)
B = input signal level 50 dB(fW)
C = input signal level 70 dB(fW)

Page 56

Figure 6

Replace the caption by:

A = 30 dB(fW)
deviation ±75 kHz
B = 70 dB(fW)

Page 58

Figure 10

Increase all abscissa values by 30 dB.

Pages 60 and 61

Figures 13a and 13b

Replace the caption by:

$\left.\begin{array}{l}\text{Curve A = 80 dB(fW)}\\ \text{Curve B = 50 dB(fW)}\end{array}\right\}$ available power of the wanted signal

Page 62

Figure 14

Replace the specification of filter F_1 by:

F_1 = band-pass filter from 200 Hz to 15 kHz (see Figure 1a, page 53).

Page 66

Figure 18

Increase all abscissa values by 30 dB.

Figure 19

Add a caption to the ordinate axis:

Noise limited sensitivity

Increase all ordinate values by 30 dB.

Page 68

Figure 21

Increase all abscissa values by 30 dB.

Page 71

Figure A2

In the first line of the caption amend "200 Hz" *to* "200".

Printed at Dee Kay Printers, New Delhi-110015, India

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This Indian Standard has been developed from Doc : No. LTD 20 (983).

Amendments Issued Since Publication

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